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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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International Commission on Methods of Testing Cast Iron

One of the main objects which the International Commission on Methods of Testing Cast Iron has had before it since its inception has been the exploration of the possibility of establishing some measure of international standardisation in methods of testing cast iron. Naturally the development and acceptance of such an international specification will take considerable time, and the work done to date has, if anything, emphasised the difficulties and delays which are inevitable in endeavouring to bring about accord even on some of the relatively minor aspects of the problem.

Naturally, the first step in considering a question such as this is to study the present position, and one of the chief activities of the Commission during the past few years has been, therefore, the collection of specifications and data on existing methods of testing cast iron in the various countries. This work has now been completed, thanks to the untiring efforts of the President of the Commission, M. J. Léonard, and in spite of the long delays imposed by such countries as our own, in which the position with regard to specifications was in a state of flux.

The situation to-day is now summarised in a report presented by M. Léonard in "La Fonderie Belge," and this report should be studied by all interested in the general question of testing cast iron and in the relative merits of the different methods standardised throughout the world. In the foreword of the report, M. Léonard emphasises that in the last two or three years important changes have taken place in the testing position in Italy, Poland and Great Britain. A full report has not been possible in the case of Spain owing to the difficulty of getting in touch with the necessary officials, and a note of sympathy is extended to his technical colleagues in Spain in their troubles.

The body of the report contains details of the existing specifications for testing cast iron in Germany, Belgium, U.S.A., France, Great Britain, Holland, Italy, Poland, Switzerland and Czecho-Slovakia. Space does not permit of giving full consideration to the conclusions which can be drawn from studying this report. The following points, however, taken from the summary, may be of interest.

The usefulness of the transverse test conducted generally on large bars is universally admitted. A departure from general practice is found in the case of France, where a small bar (8 by 10 mm. rectangular section) is used. The large bar is recommended in all other countries, and these divide themselves naturally into two classes. (1) Germany, Italy, Switzerland and Czecho-Slovakia employ a test-bar of 30 mm. (1.18 in.) diameter, distance between supports being 600 mm. (23.6 in.); one bar only is employed for all dimensions of castings. (2) In England, U.S.A. and Holland three or more sizes of test-bars are used, dimensions being related to the section of the casting. The 1.2 in. diameter bar is standard in both Great Britain and the U.S.A. M. Léonard concludes, from studying the data, that standardisation of the transverse test can be envisaged, but to make it complete it will be necessary for minor modifications of the test conditions imposed in the different countries. The consideration of the possibility of such modifications will form the future work of the Commission.

In considering the preparation of test-bars, full recognition is given to the necessity of standardised practice to eliminate variables in casting conditions, and attempts are made in some countries to specify a standard type of mould for the production of the bars. The method of quoting the results of the transverse test is given some consideration, and the weight of opinion seems to be in favour of the use of the term "transverse rupture stress" given in load per unit of area. The usefulness of measuring the deflection is also considered, and the possibility of standardising a transverse test alone to measure the quality of cast iron is raised.

With reference to the tensile test, the usefulness of this test is questioned, although it would appear to be widely employed in the different countries. Methods of taking tensile test-pieces, it is pointed out, vary and consideration will have to be given to standardisation of this factor. Numerous other points are considered—for example, the desirability of specifying Brinell hardness, the general question of the usefulness of the small test-pieces as used in France and the desirability from the general point of view of including other tests in general specifications for cast iron.

It is evident from the report that a study of the existing specifications opens up innumerable questions which will have to be given due consideration before any measure of accord can be reached. In the meantime, however, although the numerous differences of opinion are noted between the different countries, M. Léonard's report does seem to indicate some, if remote, possibility of agreement with regard to the major aspects of the problem of the international standardisation of methods of testing cast iron.

Institute of British Foundrymen

ELECTION OF NEW MEMBERS

At a meeting of the Council of the Institute of British Foundrymen in Sheffield on April 9, the following were elected to the various grades of membership.

As Subscribing Firms.

Austral Ironworks (E. W. Tarry & Company, Limited), Nugget and Anderson Streets, Johannesburg (representative, W. J. Petersen); British Foundry Units, Limited, Retort Works, Chesterfield (representative, C. Wood); Thomas Broadbent & Sons, Limited, Central Ironworks, Huddersfield (representative, B. Broadbent).

As Members.

J. H. Bacon, metallurgist, Stanton Ironworks Company, Limited, near Nottingham; A. Burn-Callander, sales engineer, H. Gardner & Company, Limited, London, E.C.3; C. H. Claxton, works manager, T. Hill-Jones, Limited, London, E.3; G. W. Daglish, representative, Stewarts and Lloyds, Limited; J. G. Finlay, B.Sc., sales manager, Steel Sales Company of South Africa, Johannesburg; S. G. Fisher, production engineer, Suffolk Iron Foundry (1920), Limited, Stowmarket; F. O. Gibson, foundry director, O. Gibson & Sons, Leeds; J. E. Hayes, representative, Foundry Services, Limited, Birmingham; F. Ives, master patternmaker, Follyhall Patternworks, Huddersfield; C. A. B. Lindop, malleable ironfounder, Junction Foundry, Walsall; A. E. McRae Smith, Research and Development Department, Mond Nickel Company, Limited; H. Oliver, assistant sales manager, Leigh & Sillavan, Limited, Manchester; W. J. Petersen, manager, Austral Iron Works, Johannesburg; C. Ramsden, technical representative, General Refractories, Limited, Middlesbrough; G. Rawcliffe, manager, J. Pilling & Sons, Limited, Colne, Lancs.; A. C. Rhodes, director, B. Rhodes & Son, Limited, London, E.3; E. M. Smeeth, iron and steel agent, T. S. Smeeth, Bradford.

As Associate Members.

H. M. Abbott, patternshop foreman, Suffolk Iron Foundry (1920), Limited, Stowmarket; K. Aldersley, metallurgical chemist, Keighley Laboratories, Limited; G. K. Beattie, brass moulder, Beattie & Company, Glasgow; F. A. Butler, iron moulder, Crossley Bros., Limited; A. M. Campbell, moulder, G. & J. Weir, Limited, Cathcart; W. Catherall, foreman moulder, Kitson & Company, Limited, Leeds; K. Chand, foreman moulder, Uganda Sugar Factory, Limited, Lugazi, Uganda; L. P. Cheng, B.Sc.(Eng.), engineer, Cochranes (Middlesbrough) Foundry, Limited; A. Cudworth, patternmaker, W. R. F. Ives, Follyhall Pattern Works, Huddersfield; E. Daybell, foundry foreman, British Thomson-Houston Company, Limited, Rugby; H. Drewett, iron moulder, Bradley & Craven, Limited, Wakefield; F. B. Fenton, foundry foreman, Foundry & Engineering Company (West Bromwich), Limited; T. R. Goodwin, works chemist, Smith & Wellstood, Limited, Bonnybridge; A. E. Harford, foundry foreman, J. Shervell, Limited, Portsmouth; C. P. Hardy, production engineer, Suffolk Iron Foundry (1920), Limited, Stowmarket; H. C. Heggie, metallurgical chemist, Austin Motor Company, Limited, Birmingham; G. Hobson, assistant foundry foreman, Entwisle & Kenyon, Limited, Accrington; A. Hodgson, foreman, J. Parkinson & Son, Shipley; J. Hunt, iron moulder, J. H. Smethurst & Son; P. L. Kathuria, student apprentice, M.E. College, Moghalpura; E. Mann, foundry accountant, J. Parkinson & Son, Shipley; W. Montgomery, metallurgical chemist, The Foundry Technical Institute, Falkirk (B.C.I.R.A.); G. K. Ogale, M.Sc., B.Met., consulting metallurgist, Dombivali, Dist. Thana, India; W. F. Osborne, iron moulder, Tortoise Foundry Company, Halstead; W. L. Proctor, B.Sc., moulder, J. Wright & Company, Limited, Birmingham; J. C. Rhodes, foreman patternmaker, Repton Foundry, Limited, Tividale, Tipton; A. S. Richards, iron moulder, Consett Iron Company, Limited, Consett; J. A. Shaw, foreman patternmaker, Humber, Limited, Coventry; F. Travis, moulder, W. B. White & Sons, Limited, Colne; S. Unsworth, chargehand patternmaker, Consett Iron Company, Limited, Consett; J. Ward, foundry foreman, Blakey's Boot Protectors, Limited, Leeds.

As Associates.

J. Cassidy, iron moulder; B. Chisholm, moulder; B. Cunningham, moulder; G. Fraser, iron moulder; T. Glendinning, iron moulder; E. Henderson, core maker; T. A. Purvis, patternmaker; W. N. Surtees, patternmaker (all with the Consett Iron Company, Limited, Consett).

As Associate (Student).

G. Wood, apprentice moulder, Consett Iron Company, Limited, Consett.

Glasgow Councillors Visit Letchworth Steelfoundry

Members of the Glasgow City Council who recently paid a visit to Letchworth, to inspect the residential and industrial features of the garden city, made a tour of the foundry and engineering works of Kryn & Lahy (1928), Limited. Our photograph shows some of the party watching a Tropenas side-blown converter in full blast. The Glasgow visitors expressed surprise that such a large steelfoundry was established so near to London, a district with which they had associated the lighter engineering trades.

The Fettling Shop

The discussion of the Paper* by Mr. John Cameron, jun., to the Scottish Branch of the Institute of British Foundrymen, revolved round the subjects of pneumatic hammers and the hydro-blast method cleaning. It was opened by MR. E. J. ROSS (Branch-President), who said that the Paper dealt with a phase of foundry-work which was not often discussed. Mr. Cameron had mentioned various ways of tackling the work, and had referred to the noise of the rumbler; but in a shop where there were half a dozen pneumatic chisels and some grinders working, the noise of the rumbler would never be noticed. In regard to the rotary type of grinder, the turbine type was undoubtedly easier to handle, but personal opinion was that it cost more in upkeep than the piston type. The latter seemed to stand up to the work better, being positive in action, although it was not so convenient to handle. Probably there were other members present who had found different results from those given by Mr. Cameron, and he felt sure that the author would be pleased to hear their experiences.

MR. H. D. CAMPBELL, after congratulating the author, said that fettling costs were an important item, and although Mr. Cameron had not said very much about it, he must have reduced them considerably. Much money could easily be wasted in fettling castings, and he thought the department required much more attention than was often given to it.

MR. R. BALLANTINE said it occurred to him to ask the question, "Is the fettling shop essential?" He had often heard the patternshop referred to as a necessary evil, and he began to think there actually was a lot of evil about it. He suggested that it was largely due to the many inaccuracies of the patternmaker, coupled with moulders' carelessness, that so much fettling was required. A large part of the fins and flashes which arose in casting was in many instances due to poor patternmaking, and that caused so much work in the fettling shop. He looked forward to improvements in the very near future which would bring about a large reduction in fettling.

The Hydro-Blast

MR. D. SHARPE said that he saw the hydro-blast process at work at Allis Chambers about ten years ago, and again last year, when he was in America. He found that they had reduced the pressure very considerably, which made it more attractive. He thought, however, that it would mainly be used for removing the cores and cleaning the heaviest type of castings.

MR. J. CAMERON, JUN., expressed his indebtedness to Mr. Ross for his kind references to the Paper. He confessed that when he had written the Paper he knew much more about the costs of fettling than he did when he started. He sympathised with Mr. Ballantine's remarks, and would be very pleased if he could eliminate the fettling. He agreed that the pattern could make or mar a casting; unfortunately, some of the specimens of timber sent in as patterns were not all that could be desired, but the foundryman had to use them and make the best job possible. The result was often that the castings were little more than blocks of metal which the fettler had to chop and hew to make some sort of resemblance to what was required. No fettler, however good the apparatus with which he worked, could make good the deficiencies of bad patternmaking.

He was interested in Mr. Sharpe's remarks about the hydro-blast, and agreed that if a reduced pressure could be used, it would enhance the appeal of the process.

A hearty vote of thanks was accorded to Mr. Cameron for his Paper.

* "Equipping of a Fettling Shop." See FOUNDRY TRADE JOURNAL, March 24, 1938, pp. 255-7.

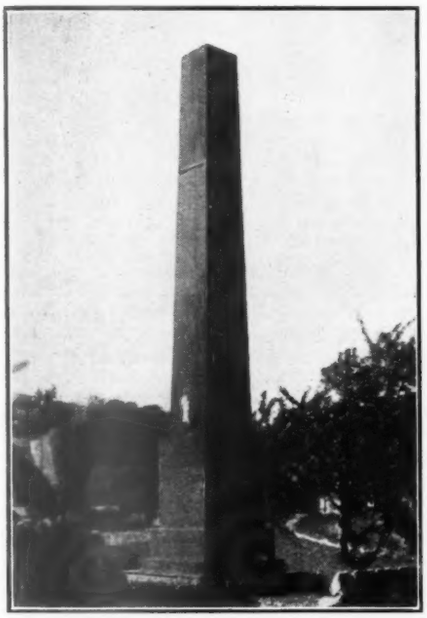
John Wilkinson—His Craft and Times

By J. E. COOKE

This address was given by Mr. Cooke, who is honorary secretary of the Lancashire Branch of the Institute of British Foundrymen, to members of the Junior Section. Our illustrations of the Wilkinson Memorial at Lindale-in-Cartmel, Cumberland, are intended to show the ill-repair into which the memorial has fallen. It will be remembered that a committee of the Lancashire Branch is studying ways and means for its restoration.

It is rather difficult in these days to separate the activities of John Wilkinson from those of his father, Isaac Wilkinson, and of his brother, William Wilkinson. Many things are attributed to John Wilkinson which, if history had been accurately recorded, ought to have been credited to either Wilkinson senior or to John's younger brother, William. If by chance some of the references on this occasion are proved to be inaccurate, it is only because of the inadequate state of records, because when one does any reading on this subject, one finds various authorities contradicting each other.

Some two years ago, in sketching the earliest history of the foundryman's industry in this country, the author referred particularly to the condition of the common people in mediæval times. He did so in order to etch in a suitable social background behind his subject, and he proposes to deal with Wilkinson in a similar manner.



The John Wilkinson Memorial at Lindale-in-Cartmel, Cumberland.

Changing Conditions

The feudal system was dealt with on the previous occasion referred to, and some idea was given of how the guild system in the country permitted the organisation of labour in those days, and how serviceable the system was to the communities as they then existed. With the decline of the feudal system, from about the end of the fifteenth century onwards, a gradual change came about in the relationship of the feudal laws to the peasantry of the period, or alternatively to the guild craftsmen. The craft system gradually declined and the face of England changed slightly. In some respects it improved; the agricultural system, for example, improved for a considerable time until the struggle between King Charles and Parliament resulted in the denuding of the country, because the labourers joined the armed forces of both sides.

At the end of the struggle, which went on from 1640 odd to about 1650, agriculture was in a particularly poor state, and the iron industry had almost gone out of existence. Legislation was partly responsible for that decline. The fuel used in the iron foundries was charcoal, which is best made from very hard wood; but hard woods were used for ships, and the people responsible for the fortunes of the country received protests that the use of hard woods for charcoal to be used for foundry purposes was denying the shipbuilders a source of useful material. This led to several peculiar results. For example, the Sussex iron industry, which had been the only flourishing iron industry in this country, declined altogether, so that "wealden iron" now only exists in one or two instances as museum specimens, and perhaps as one or two portions of the railings round St. Paul's Cathedral. Some of the workers who had been engaged in the Sussex iron industry migrated. Probably the success of the iron industry on the Clyde is due to the fact that legislation in England forced many iron foundries, who were still persistent enough to try to carry on their work, to find some tract of the country where timber, and therefore, charcoal, could be obtained for fuel.

It was probably because of that that Wilkinson's father managed to retain what craftsmen he employed, because he lived in a part of the country which was still able to provide the fuel that went towards making the raw material with which iron was melted.

Foreign Relationships

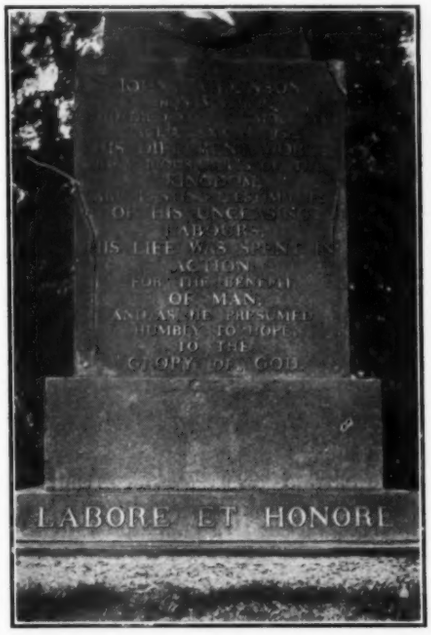
John Wilkinson was born in 1728, and he died in 1808 at the age of 80 years. That period from 1728 to 1808 was one which has many parallels and also contrasts with the present era. William and Mary reigned till 1713, which was 15 years before Wilkinson was born. John Locke, the great philosopher, died in 1704, and it was Locke's writings, developed by Rousseau and Voltaire, that brought about the French Revolution in 1789. One thing of especial interest to Manchester people is probably that in 1745, when Wilkinson would be 17 years of age, Charles Edward, the young Pretender, marched into Manchester. Overseas, the British Empire was just beginning to be founded. Britain and France were at daggers drawn. The British took several French towns in Europe and the French took Madras and several towns in India. Finally, the British drove the French out of India, and also out of Canada. In those wars, France, Austria and Russia became allies against Prussia and Britain. During Wilkinson's life, the United States declared their independence. France was declared bankrupt in 1787. The Storming of the Bastille took place in 1789, and the rise of Napoleon followed, ending with Waterloo.

The First Factory Act

It was not until 1819, eleven years after Wilkinson's death, that the first Factory Act was passed in this country, and with it was associated Robert Owen, the famous reformer. During the gradual changes, there was the beginning of what is now termed the Industrial Revolution. The country was gradually turning from agriculture to industrialism, largely due to the fact that certain inventions gave Great Britain an opportunity of providing herself with machinery of one sort or another, when the discovery of coal and iron was found to be of vital importance, particularly the substitution of coal for charcoal as fuel. These factors acted in favour of this country for many years.

Bridges and Lighthouses

When Wilkinson was born, there was only a single bridge across the Thames in London; and Liverpool had a population of only 6,000, with only one dock, the first dock in this country. There was no dock on the Thames, at least no public dock. The East Indiamen ships which came up the river with 800 tons of cargo had to have their cargo "lightered" out of them by barges, and it took a month to unload the cargo and take it ashore. Some of the modern cranes could lift that out in four lifts. The trip from London to Edinburgh was done by sea in four or five days if the winds were favourable, but the voyage took three or four weeks in adverse winds. Early in 1800, it took six weeks to bring a regiment of militia from Cork harbour to Colchester, because of adverse winds. Bridge building as an art was just beginning. The old bridges were not suitable for traffic, but there were no roads of any consequence to make them a necessity, although roads were beginning to develop. It is rather interesting to know that the old stage coaches made an average speed of only four miles an hour.



The Base of the Wilkinson Memorial, showing the Inscription and Two Major Cracks.

Eddystone lighthouse, the first permanent structure of its kind in this country, was not built until 1759, which was 31 years after Wilkinson's birth. Before the arrival of the lighthouse as known to-day, it was possible by political influence to secure permission to erect a lighthouse, and then levy toll on all vessels which passed. One highly respected Quaker obtained permission to erect a lighthouse, and, having made a fortune out of it, sold it for £40,000.

James Brindley, who constructed the first canal in this country for the third Earl of Egerton, from Worsley to Manchester, for the purpose of carrying coal, which was just beginning to be used as a fuel, began that construction in 1789. In Scotland, Meikle, who was probably

the forerunner of most modern engineers, was beginning in that period, between 1750 and 1790, to develop mills. There was a scarcity of agricultural labourers, and a paucity of crops, and it was felt desirable to try to find some mechanical means of carrying out threshing and winnowing operations, and Meikle invented certain mechanical devices for use as flails to substitute hand labour. Some of them were driven by water power and some by wind power.

From Meikle's time sprang up that peculiar race known as patternmakers. Meikle was a millwright, and the millwright has become to-day the patternmaker. Formerly the millwright actually carried out all the construction work in connection with mechanical devices in mills before the advent of the steam engine. It is interesting to know that Meikle was the first man who was known in connection with the foundry industry to use cast-iron pinions, which were used in place of the old wooden pinions, usually cut out of pear wood, apple wood or other hard woods.

Boulton and Watt developed the steam engine, and from this time may be said to date the development of the use of mechanical means in substitution for hand labour. The steam engine was of very great importance, because it did not depend upon the amount of wind that was available, and its source of power could not dry up in drought, or freeze in frost.

When the Peace of Paris took place in 1763, leaving Britain with India and Canada, a period of peace set in when development could occur. Wilkinson would then be a man of very nearly 40 years of age. In 1740 there was only about 1,700 tons of pig-iron made in this country. At the time of Wilkinson's death, it had risen to about a quarter of a million tons, so it can be seen that the use of pig-iron developed very rapidly in the 60 years which cover the most active portion of Wilkinson's life. This was largely due to the fact that coke had been developed as a result of the experiments in 1840 of Dud Dudley, the forerunner of the present Earl of Dudley. Abraham Darby eventually brought in the use of coke as a suitable fuel for foundry practice, and charcoal iron gradually went out of existence. Wrought iron, too, declined very rapidly as pig-iron rose.

The Wilkinson Family Beginnings

Isaac Wilkinson, the father of John, was born at Little Clifton, near Workington. There was a charcoal furnace there which was noticed by a French writer in the period from 1763 to 1765. The district was largely woodland, and there was plenty of charcoal and hematite iron on Cleator Moor. Coal was there, too, but nobody knew about it. Darby and Ford, at Coalbrookdale, had been experimenting with coke, and theirs was the first successful use of it, between 1718 and 1735. Clifton Furnace, worked by Wilkinson senior was still in existence about 1830, but now only the name Furnace Farm exists in that district.

It is believed that John Wilkinson was born in a farm cart, whilst his parents were on their way to Workington market. They managed during those days, apparently, to combine agriculture and the foundry work. It is known that the charcoal supplies of the district were becoming exhausted, because before Wilkinson was ten years of age, his parents migrated to Backbarrow, a picturesque little village about three miles from the foot of the Windermere Lake. It is a vale between two gently rising hills, where abundant supplies of coppice wood exist even to this day. To-day the wood is largely used for the making of baskets and for various domestic village industries, and for the turning of bobbins rather than for the purposes of the iron foundry.

The Pot Foundry

Isaac Wilkinson was known as a pot founder. In those days the word was spelled ffounder. There is still a remarkably large trade in pot founding for the African market. Probably Wilkinson senior made the three-legged pots that hung over the farmhouse fires, and which may still exist in many of the old farmhouses in that district. The furnace is still there, and until recent years one side of it was used as a public bakehouse for the district, where the ladies of the village took their bread to bake on weekdays and their Sunday joint to roast on Sundays in the stone ovens heated by the heat from the furnace.

Wilkinson senior had a novel idea at Backbarrow. The furnace belonged to somebody else, but he bought the molten iron, carried it across the road, and cast it into pots and irons that were used for box irons for ironing the laces of the dandy of the period.

Wilkinson managed to make quite a successful business by buying the molten iron on one side of the road and casting it on the other. He must have been rather prosperous, because the records show that at the end of a certain period of trading Wilkinson senior had £770 in the bank. The castings he made he instantly sold to the company he bought the molten iron from.

Early Patents

Wilkinson took out a patent in 1738 for the manufacture of box smoothing irons. It is to be remembered that Abraham Darby had actually patented the making of castings in dry-sand moulding in a flask in 1707, and the work was carried on behind plugged keyholes, and nobody was allowed to know exactly how this art of moulding in flasks with dry sand was carried out. Public morality was not very high at that time and it was considered quite legitimate for anyone to obtain by hook or by crook employment in the place where one of these secret processes was being carried out and find out all about the process; then he would relinquish the job and set out to copy the secret process. Probably this was why Abraham Darby was unable to retain the rights of his patent, because other people found out his method.

Abraham Darby's method of taking out the interior by means of a core was really the beginning of modern foundry practice. If Wilkinson senior came by it in a way he should not have done, that is no business of ours.

John Wilkinson was sent to school at Kendal, and had brothers and sisters, but the only one who need be mentioned is the brother who later became his partner, William, together with the second daughter, Mary, who married Dr. Joseph Priestley, the discoverer of oxygen. Wilkinson senior in 1744 bought Wilson House, on the Winster, near Lindale, Cartmel. Here he had bloomeries. Apparently charcoal was beginning to decline in quantity there, because he conceived the idea of using the peat moss as a fuel. The old charcoal furnace did not carry a very heavy load of metal, and the modern heavy burden was not used, so the fuel had not to be as strong as modern coke has to be. Wilkinson senior probably argued that there was very little difference between peat moss and charcoal, but his experiments in this direction were unsuccessful.

He was a vigorous sort of man. He cut a short canal to enable supplies to be brought up the river Winster, and used the stream past his house for the purpose of damming the water to drive a mill. There seems to have been a small silk factory in the village at the time—one of those small domestic factories that existed long before the factories as now known came into existence.

The Iron Boat

It was there that the original iron boat was constructed. Many people claim that John Wilkinson invented the first iron boat, though by some this statement is received with reserve. It is a personal opinion that, if that discovery should be attributed to anybody, it should be ascribed to Wilkinson's father and not to Wilkinson himself. Many people hold that view, and the tarn of the village of Winster has been unsuccessfully dragged with the object of discovering the original iron boat. It has not been discovered up to now, but it is probable that that little stretch of the river Winster first saw the iron boat used as a substitute for the wooden barge for shipping ore. That is probably a legitimate speculation to make.

Wilkinson's Career

After Wilkinson left school at Kendal he was apprenticed in Liverpool to a merchant from 1745 to 1750. He married Miss Mawdsley in 1775, but she died 10 months later. He was again married, this time to a Miss Lee, of Wroxeter, in 1763. This lady had a private fortune.

Isaac Wilkinson, in 1753, took over a charcoal furnace at Bersham, two miles from Wrexham, and five years later took out a patent for casting guns and such like articles in dried sand and in iron boxes. There is little known of John Wilkinson between the time of his leaving school and the year 1775, except that he was working at Brymbo, near Wrexham, and then he went to Broseley, on the Severn, in Shropshire. It was there in 1775 he ordered for his works the first steam engine ever installed in this country—that is distinct from a mine. At Broseley, just over 14 miles from Shrewsbury, he had coal and ore, and it gave him opportunities for smelting and founding. Quite a number of cannon were cast there, and some of them, disguised as water pipes, passed to the Continent and were actually used against this country. It is known, of course, that many of these were transported in an iron boat. There was a good deal of stir about the launching of this iron boat on the Severn, but probably the first iron boat was that used at Wilson House, Cartmel, by John Wilkinson's father.

Historical Associations

Perhaps the most important work Wilkinson did was in association with Boulton and Watt. These two were both engineers who had been connected with pumping machinery for mines, particularly in Cornwall, which were utilising the Newcomen engine. The Newcomen engine was a steam-operated engine which did not have the modern type of valve. It simply worked two long beams and comparatively recently these Newcomen engines were to be seen in operation. Probably it is impossible to see any now; the last one seen by the author was at the steelworks at Barrow-in-Furness. There were a number in the mines in the Furness district at one time, but they have all disappeared, though it is just possible that one is working at the Barrow steelworks yet. Of course, there are examples to be found in the Science and Art Museum in London, and other museums.

This Newcomen engine actually did apply steam to the movement of mechanically-operated parts, but it had its disadvantages. Its efficiency was not high, and Boulton and Watt experimented with valves, cylinders and pistons until they discovered what they called a "gire engine" which they felt was a substitute for the Newcomen engine. There was a battle royal between those people who believed that nothing could beat the Newcomen engine and those who thought it was antiquated since the Boulton and Watt engine had been introduced.

Boulton and Watt, however, had a great deal of trouble with cylinders. They first of all tried Carron in Scotland. Dr. Roebuck was the leading force in connection with the Carron Iron Works, but he was not very successful in the casting of cylinders sufficiently true in the bore for their purpose. There were no machine tools to machine the cylinders in those days; they tried making them of block tin, but it was found impossible to get them to within ⅛ in. of truly circular. Thus, although the engine would work, it did not work very efficiently.

His Greatest Invention

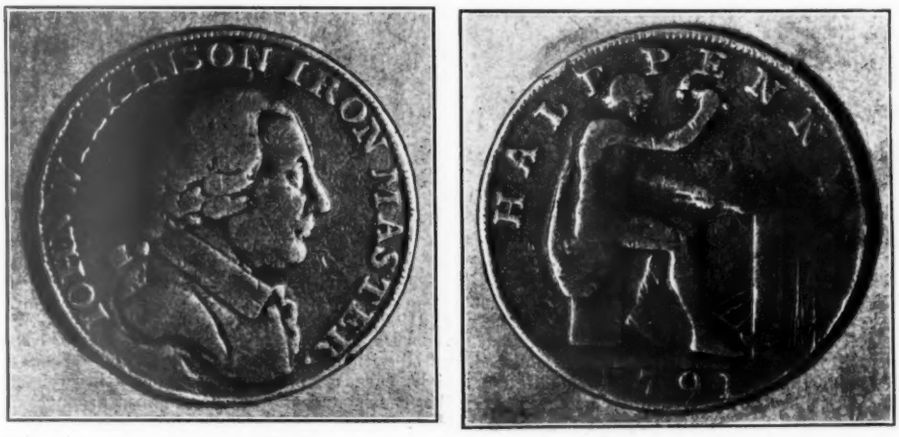
Efforts to make them of wrought-iron strips bound with wrought-iron bands were no more

successful than the other type. Eventually, Wilkinson was asked if he would have a try, and he succeeded in casting a cylinder quite successfully; moreover, Wilkinson devised the first boring mill which enabled them to be bored true, to within about $\frac{1}{16}$ in. Those having experience of modern machine-shop practice will be inclined to smile at that, but obviously the improvement in accuracy from $\frac{3}{8}$ in. to $\frac{1}{16}$ in. was a remarkable advance. Probably the greatest work which John Wilkinson accomplished was that in connection with the Boulton and Watt engines. He was always willing to assist them, from that date onwards, in developing the use of the engine, not only for the pumps of Cornwall, but he ordered one himself for his works at Broseley, and his flour mills, the Albion Mills, on the Thames, were set up with the Boulton and Watt engine.

At these Albion Mills, for the very first time in human experience, the machinery not only drove the mill, but actually provided the means of lifting cargo out of the holds of ships, and moving them over the floors of the warehouse. Most probably, both the King and the Prime Minister visited the Albion Mills to see this wonderful engine, not without a good deal of temerity on the part of the Prime Minister.

ing of machinery began the factory system, and it is interesting to speculate what might have happened if the hour had not produced the man. The steam engine depended for its success in that particular instance upon the ironfounder, who not only provided the casting but devised the tool for boring it sufficiently accurately. Other people have improved upon that beginning, but the first step is none the less noteworthy.

Wilkinson and his brother were consulted by several foreign Governments, particularly the French Government, when there was peace between this country and France, and it was probably due to their advice that the great Schneider works became the predominant iron works of France. Queen Catherine of Russia was very interested in the productions of Boulton and Watt and also Wilkinson, and probably some of the advance made in Russia during her reign was due to association with these three people.



Obverse and Reverse of a Wilkinson Halfpenny Token, in the Possession of the Editor. Around the edge of the coin in Roman lettering are impressed the names of his works—Bradley, Bersham, Willey and Snedshill.

Other Accomplishments

Wilkinson, besides casting cylinders of that character, should be remembered because he cast the first iron bridge and is also reputed to have built iron houses, but there is no definite knowledge of these. It is known that there was an iron church with an iron pulpit in Staffordshire which Wilkinson produced. He made the first iron-man for cutting coal. He made two iron coffins for himself, and he made an obelisk of iron for his grave. This weighs about 20 to 30 tons and still stands in the village in Lindale-in-Cartmel.

After his furnace had been successfully run on the "fire engine," as it was called by Boulton and Watt, he turned his attention to rolling and the making of nails and so forth, and ordered an engine for that purpose to replace the water-driven mill that he had previously had. Boulton, in a letter to Watt, said "There is not a single water mill at work in the county of Staffordshire (owing to drought or frost). Were it not for Wilkinson's steam the poor nailers must have perished, but his mill goes on rolling and slitting ten tons a day, carried away as fast as it can be bundled. Thus employment and subsistence are assured."

The above gives a fair outline of what Wilkinson did, and it seems desirable to consider it against the social conditions he lived in. Domestic industry was declining, and with the growth of the application of steam to the turn-

More extensive literature upon this subject is provided by "The Lives of the Engineers," by Samuel Smiles, upon which the author has drawn, but there is nothing there about Wilkinson, except a fragmentary note. The histories of Smeaton, Meikle, Watt and Boulton, and the engineers' devices, lighthouses, locks, docks, public works, drainage, harbours, and so forth, are very interestingly set out in this book. Samuel Smiles wrote a book that everybody scoffs at to-day—"Self-Help," but he wrote several excellent books besides.

Personal Character

That Wilkinson was a hard character there is no doubt. He lived at a time when the ideal was to be country squire, and Wilkinson had that same ideal; he did not wish to be known as an iron founder. He built a big house on an island, and reclaimed a large piece of land from the sea. He loved to ride round on a white horse, and there is a legend in Staffordshire that he is still to be seen riding on a white horse. He was energetic, decisive and clear in everything he did. He was very enterprising, but very pig-headed in many instances, a "homespun" character, very quick-tempered, very forthright in speech. He lived life fully; he lived every hour he was awake, and at the time of his death he was quite a wealthy man. The Government of this country owed him about a million pounds, but it is quite a long story, and that million pounds never passed to anybody. It was uncertain to whom it belonged when Wilkinson died, and there were long law suits about it, so that it was finally all wasted in litigation.

An interesting light on his character is revealed by the incident on one occasion when he quarrelled with his brother about a statement of affairs between them and the disposition of machinery that was existing. He seized a hammer, went into the works, and smashed up the machinery. That was the way he used of settling the argument.

He was a good friend to his brother-in-law, Priestley, the political reformer, in times when political reformers were anathema to everybody in this country. When his works was threatened by a mob, he had his men standing by with steam pipes to turn on the rioters. The mob then attacked Priestley's house, and when Priestley became an outlaw at about the time of the French Revolution, and he had to fly to America, Wilkinson provided the money to send him there, and Priestley never returned.

Amongst other things, Wilkinson devised his own coinage and paper money. There was no banking system such as is now known. It was difficult to pay people in the new conditions that were arising, and Wilkinson's paper money and coinage were current in many parts of the country. The Wilkinson Medal which is presented to the Junior Section of the Lancashire Branch of the Institute is merely a reproduction of one of the coins which Wilkinson minted. Boulton and Watt actually produced the first minting machine, and they probably produced Wilkinson's coins.

The John Wilkinson Competition

The John Wilkinson Medal is awarded to the member of the Junior Section who most successfully competes in an annual competition. Last year it was not held because, in the view of the Council of the Institute, there was not sufficient interest being taken in the competition, and the object of the present lecture is an endeavour to ensure the continuance of the competition. It was hoped that this subject of John Wilkinson might be delivered to another association, but it occurred to the author that he might make it popular enough to appeal to younger people, and at the same time do a service to the Section by pointing out that it was not for nothing that that medal was named after John Wilkinson.

An Encouraging Response

At the conclusion of his address Mr. Cooke asked how many of those present would be likely to enter for the John Wilkinson Medal, and the response was so satisfactory that he announced that the competition would certainly be held this year. It would be open to persons under 25 years of age, and there would be alternative examination papers on iron foundry practice and non-ferrous practice.

Vote of Thanks

Mr. Flower proposed a vote of thanks to the lecturer, and Mr. W. Holland seconded. Mr. Holland observed that he had seen cranes in use, made in 1795, at Wilkinson's old foundry at Broseley, lifting jobs up to eight tons.

Mr. Cooke, responding, said that in many parts of the country there were still traces of the old bloomeries, which were used in the days when nobody knew about heating iron sufficiently to melt it. They knew enough to bring it to a pasty state and puddle the product, which was a spongy iron mixed with gangue on the hearth of the furnace. It was afterwards hammered and forged, and hammered again to remove the slag completely, and that was the metal that the village blacksmith of those days used. The old cinder used probably 200 years ago could often be found. In Manchester a number of cast-iron bridges were still in existence, and a number of cast-iron pillars. At the Grand Hotel, when alterations were made, great trouble was experienced in taking out the cast-iron pillars, which were cast with cold-blast iron before hot-blast iron came into existence. John Wilkinson still had descendants in South Africa.

Acid Electric-Arc Furnace for Making Steel Castings

In 1935 the small Bessemer plant at the Van Tongelschen Stahlwerken G.m.b.H. at Güstrow, which is located a considerable distance from a supply of coal, was closed down and the whole of the steel subsequently produced in the electric furnace, states R. van Tongel in a contribution to "Stahl und Eisen." As the principal products of these works were moulded pipes and fittings and hollow products, an increasing need was felt for a steel with a high strength at both ordinary and high temperatures, with good elongation values and a high notched-bar impact value.

As regards the most economic process of steel-making, the choice lay between the basic or acid arc-furnaces and the coreless induction furnace, the cost of the latter being, however, about three times that of an electric-arc furnace of the same capacity. The arc furnace was selected; it remained to decide whether it should have a basic or acid hearth. An inquiry in this direction indicated that about 95 per cent. of the steel castings manufactured in Germany were made in basic furnaces, while theoretical and economic considerations as well as the author's own experience with acid open-hearth furnaces in Europe and the United States showed an acid lining to be preferable. The principal objections against the acid furnace were in regard to scrap, since it was feared that difficulties would be met in obtaining clean scrap free from P and S, the scrap in Germany not being graded in the same way as in the United States.

It was evident that mixed scrap could not be used in the acid furnace and that recourse would have to be made to good mill scrap of which satisfactory supplies were available from various sources. The extra cost of this scrap, it was hoped, would be recouped by economies in other directions.

R. Genwo, analysing the cost of producing electric steel in the basic arc furnace, shows that the power costs account for about 28 per cent. of the cost of the finished molten steel, while the saving with an acid furnace should be about 30 per cent., a factor which alone already affords a marked economy. Other savings should accrue from the much greater capacity of the furnace and hence lower depreciation charges, which Genwo does not take into consideration. A further argument in favour of the acid furnace was the low cost of preparation and maintenance, which on available published data was estimated at 1 Rmk. per ton of molten steel, while the corresponding charge with a basic furnace was more than three times as great.

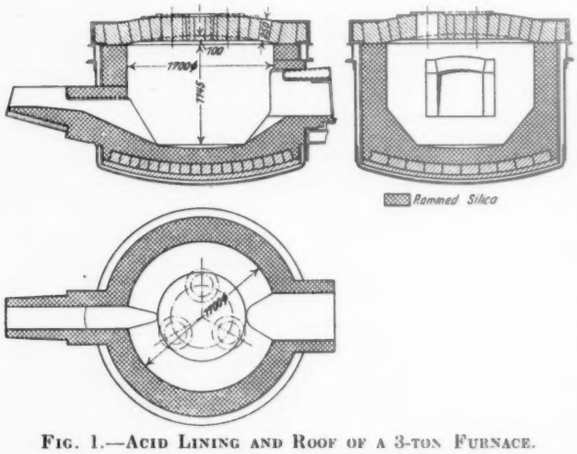


Fig. 1.—Acid Lining and Roof of a 3-ton Furnace.

A well-known advantage of the acid steel is its freedom from oxygen due to silicon reduction. The silicon extracted by reduction from the furnace lining passes into the melt in a nascent state and is hence very reactive. If the furnace and slag conditions are satisfactory, the amount of Si passing into the melt can be carefully regulated, particularly with steels containing more than 0.15 per cent. C, so that the addition of ferro-silicon can in most cases be entirely dispensed with. Giving full consideration to all the factors entailed it was finally decided to install an acid electric-arc furnace.

The 3-ton furnace installed has now been in use for over a year and has more than fulfilled all expectations. The power costs show a very much greater reduction than indicated by Genwo, owing to the elimination of the refining period and the better insulation of the bath by the acid slag: the average power consumption was 500 kilowatt-hrs. per ton, which includes melting and finishing of the steel.

The supply of scrap offered no difficulty at all; it was also observed that the danger of rusted scrap had been much overrated. As it was not possible to obtain perfectly clean scrap or turnings free from rust, scrap of all descriptions had to be used, some being frequently very uninviting and very rusty. Operation of the furnace over the course of a year showed that the attack of iron oxide on the lining was very slight, and shortly after starting up the furnace smooth operating conditions were established. The proportion of steel turnings could be increased to about 20 per cent. of the total charge, while the works' own make of scrap castings was naturally also used.

The savings compared to a basic lining were very considerable owing to the lower cost of the acid lining and the greater durability of the roof. The vertical walls were made of moistened silica rammed in place by compressed air, and the roof lined with a good grade of silica bricks (Fig. 1). This work could be conveniently carried out in 24 hrs. After reconditioning, the furnace was not fully heated up again, but the charge melted down in the cold furnace. On these occasions the larger skulls which could not be introduced through the door were also charged; the rapid heating up caused no damage to the roof or walls. The hearth appeared to have an unlimited life; after each cast it was inspected and patched, an operation taking only 5 to 10 min. The freshly-rammed walls exhibited a durability of about 300 melts. The long life of the roof, viz., 700 melts, deserved special mention, in view of the intermittent operation of the furnace. With the plant in continuous operation, the roof had a life of about 1,000 melts, towards the end of which there was a gradual increase in the power costs, due to the loss of heat through the steadily thinning lining; this increase was by no means excessive.

The average power consumption for the first 700 melts was 560 kilowatt-hrs. per ton of charge, which included a certain increase in power requirements, due to the wear of the roof. The P and S contents could be kept at an average of 0.03 to 0.04 per cent. and gave no difficulty whatsoever.

With an acid furnace the transformer should have as high a rating as possible. The acid slag, owing to its low conductivity, is more difficult to penetrate with the arc than the basic slag with a higher conductivity. High voltages should be used as low voltages are liable to give rise to troublesome surges. During the melting period, therefore, the highest practicable voltage should be employed. Melting is as a result shorter and smoother. If the voltage is too low the melting period is too long, and so much carbon can then be absorbed from the electrodes that the carbon content of the steel can only be reduced again by the addition of ore, without endangering the hearth.

Apart from austenitic-manganese steels all alloy steels can be melted in the acid furnace just as well as in the basic furnace. In fact, with chrome steels the acid lining offers the advantage that it is not attacked by the chromium oxide always formed, while much less slag is produced. It is advisable to add alloying elements only when the steel has been largely deoxidised. As deoxidation takes place in the furnace itself, there is no objection to adding the alloys to the furnace after this reaction, whereby slagging is reduced to a minimum. Difficulties are only met with when melting very mild steels with less than 0.15 per cent. C.

Pig-Iron and Steel Output

The British Iron and Steel Federation reports that the output of pig-iron in March amounted to 714,600 tons compared with 693,300 tons in February and 680,300 tons in March, 1937. Production included 161,500 tons of hematite, 403,300 tons of basic, 125,100 tons of foundry and 9,600 tons of forge iron. There were 118 furnaces in blast at the end of March compared with 124 furnaces at the end of February, eight furnaces having ceased operation during the month, and two having resumed production. The output of steel ingots and castings in March amounted to 1,115,800 tons compared with 1,057,600 tons in February, and 1,109,500 tons in March, 1937.

Despite more normal conditions in regard to iron and steel deliveries production in both departments last month continued at a relatively high level, and total output for the first three months of this year compared with that of the first quarter of 1937 was as follows:—Pig-iron, 1,934,700 tons in 1937 and 2,169,000 tons in 1938, and steel ingots and castings, 3,104,300 tons in 1937 and 3,254,800 tons in 1938. As a result of the large imports of pig-iron, it is no longer practicable to keep as high a proportion of available furnaces in blast as last year's abnormal conditions necessitated. Pig-iron production to date has already exceeded that for the corresponding period of 1937 by approximately 12 per cent., whereas steel output has been 5 per cent. higher.

B.S. Specification for Wrought Iron Chain Slings

The latest addition to the series of British Standard Specifications relating to terminal fittings for wire rope and chain has now been published under the title "Wrought Iron Chain Slings," and includes rings, links alternative to rings, egg-links and intermediate links. The prefatory sections of the specification comprise foreword, descriptive notes, notes as to design and recommendations as to working loads, and are of unusual interest as they afford information not generally accessible. The formulæ, proportions and dimensions for the various components were originated and worked out in detail by the engineering staff of the National Physical Laboratory, who were actively associated with the Committee. Like B.S.S. 394 (short link crane chain) the new specification is limited to slings and components up to and including 1½ in. The specification is also limited as to the types of sling in more general use which, however, are sufficient for the majority of normal purposes. Copies of this new Specification, No. 781—1938, can be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1. (Price 3s. 6d. each.)

Modern Methods of Sand Testing*

By WM. Y. BUCHANAN

Introduction

There are available the A.F.A. and B.C.I.R.A. test-pieces and methods of using them, so it becomes sooner or later a case of "to be or not to be." The American work is all founded on 2 in. by 2 in. test-pieces, on which has been built a remarkable edifice. This, however, is built on a rather doubtful foundation—the test-piece.

Generally speaking, the green-strength, permeability, shear, resilience, hardness and lately the flowability are not connected or associated as they should be. For example, the hardness is a localised skin hardness test, while the flowability test is determined by the depression caused by the fifth blow, which has no relation to moulding practice. Indeed, in the author's opinion, the A.F.A. test-piece is not really representative of moulding practice.

The number who have given this matter of *dimensions of test-pieces* the degree of attention which it really deserves is probably less than three in this country, and certainly not more—that is, work of the standard and volume it is proposed to use here in support of personal conclusions. Two sections alone consisted of 1,920 tests, and this was entirely repeated. The value of an opinion should be gauged by the amount of work on which it is based.

As is well known, the Institute's Sands Committee recommended the A.F.A. test for green-sand tests of routine type. The B.C.I.R.A. double-compression test was said to be useful for some research purposes. The B.C.I.R.A. Committee, however, upheld their test-piece made by double compression. The words "ap. density" have unfortunately been retained, which is evidently an invitation to every future student to attack the B.C.I.R.A. and then change to the A.F.A. method. If Index of Ramming be substituted for "green ap. density," everything is quite sound.

TABLE I.—*Densities of British Sands.*

		True density.
Chelford washed sand		2.648
Frankley sand		2.645
Leighton Buzzard Arnold No. 10		2.635
" " " " 26A		2.681
Parish's steel moulding sand		2.664
Evan's Bromsgrove sand		2.646
Deacon's Wolverhampton sharp		2.653
Doncaster red sand		2.679
Mansfield red sand		2.697
Manchester Patricroft red sand		2.640
" Ship Canal sand		2.637
Warrington sand		2.638
Worksop strong sand		2.687
" medium sand		2.647
" weak sand		2.661
Worcester red sand		2.696
Worksop sand		2.631
Wombourne		2.628
Salmon sand	Australian	2.676
Silica sand	Australian	2.660
White sand	Australian	2.668
Yellow sand	Australian	2.753

Now there is no comparison whatever possible between the A.F.A. 2 in. by 2 in. and the B.C.I.R.A. 2¼ in. by 1½ in. test-pieces as far as their results are concerned. This conclusion was also reached a number of years ago by the B.C.I.R.A.

Densities

In a previous Paper,† Table I showed the densities of a number of sands and other foundry materials. The sands were shown not to vary very much, and it is interesting to note that the true density of clay—bentonite or Colbond—is practically the same as sand, so that the addition of these clays does not influence the true density of these sands. Coal-dust is the only material which alters the density considerably.

Table I gives the true densities of a further number of sands supplied by the B.C.I.R.A., and the author would be glad to receive a small sample of any sands not included in the lists, so that their densities may be added.

Accuracy

The figures given here were obtained at 20 deg. C., using a 50-ml. density bottle and weighing 100.0000 ± 5 grms. of sand, and calculating the results using seven-figure logarithms in order to make the accuracy of the estimation as high as possible. All density determinations were done in duplicate, and the accuracy of the method on any one sample was found to be under ± 0.005 and often under ± 0.001.

The use of the large density bottle described in a previous Paper* was discontinued, as no sand testing balance seems to be sufficiently accurate for this work.

On examining the figures given in Table I, the average density was found to be 2.658 and the highest and lowest to be 2.63 and 2.69 respectively. Thus, the variation of density would be plus or minus 0.03. At Index of Ramming 13, this variation of density would be 12.4 to 13.6. This is equivalent to 11 per cent. difference in green-strength and 20 per cent. difference in permeability, for example.

Index of Ramming Method

The Index of Ramming is defined as: Index of Ramming $= \left(\frac{\text{dry apparent density}}{\text{true density}}\right) \times 100 - 42$, and is intended to give a true standard ramming, *i.e.*, the same number of grains of material per unit of space, and in the case of small grains two half-grains would replace one whole grain. Thus the Index of Ramming method is free from the influence of flowability and density.

The A.F.A. test, besides being, to the author's mind, improperly rammed and improperly designed, is subject to variation of ramming due to flowability, with change of water, clay and grain size, and also distribution.

The Index of Ramming was intended naturally to be used with the correctly-designed and uniformly-rammed 1½ in. diameter double-compression test-piece, and a great deal of work (several thousands of tests) was carried out by both methods. It was evident from the results that any rational comparison with the A.F.A. test was hopeless.

Work done by the B.C.I.R.A. some years ago brought them to the same conclusion. This work was repeated on the A.F.A. test at constant Index of Ramming, as shown later, for comparison with the A.F.A. standard method.

The Index of Ramming idea does not require the addition of any special apparatus and can be used on any test-piece. The main principle is the substitution of Index of Ramming for *green apparent density*. Thus it has the advantage of variable density at will and at the same time can be used for comparison of any sand of different true density and type. It can, therefore, do all that can be done by either the A.F.A. or the existing B.C.I.R.A. methods.

In addition, by using the A.F.A. and fixed Index of Ramming system, the flowability effect can be clearly separated and put down in exact figures. The A.F.A. test is, of course, very simple and requires no thought on the part of the operator. As a daily check on variations it can, and does, fulfil a useful purpose. There is no question of that. The errors and limitations of the A.F.A. test should be understood, as it is often represented as something more accurate than it really is, and in many cases is positively misunderstood.

TABLE II.—*Effect of Method of Ramming and Length of Test-Piece.*

Dimensions of test-piece.	2 in. by 2 in.	2 in. by 2 in.	1½ in. by 2½ in.	1½ in. by 1½ in.
Type of test-piece	A.F.A. drop wt.	A.F.A. D.C. R $\frac{1}{32}$ in.	B.C.I.R.A. std. R $\frac{1}{16}$ in.	B.C.I.R.A. red. 1 in. R $\frac{1}{32}$ in.
Weight, grms.	169	169	60.65	33.30
Permeability	82	95	137	146
Hardness Top	78	70	64	61.3
Hardness Bot.	72.6	70	63	61
Green-strength. Lbs. per sq. in.	3.95	3.34	2.30	3.06
Penetration. Mms. Top	22	21.2	25.3	24.3
Penetration. Mms. Bot.	21	21.2	25.3	24.3

Errors of A.F.A. Test-Piece

The A.F.A. test-piece was made in the standard manner, and to find the influence of the method of ramming another set of tests was made of exactly the same weight and length of the same sand by double compression. It will be seen from Table II that the standard A.F.A. test is evidently more unevenly rammed, giving lower permeability and higher green-strength, and that these errors are due to the method of ramming.

Next, to investigate the effect of dimensions, the B.C.I.R.A. test-piece was made to the same density in the same sand. Then another test-piece was made 1 in. shorter but to exactly the same density. That is, all four test-pieces were of the same density and the same sand. It will be seen that the short test-piece is stronger under compression and the permeability is higher. Note also, in these figures, evidence of the unreliability of the A.F.A. hardness test as a measure of density. The A.F.A. test-piece has a hard layer on the top which reads 78, the bottom reads 72, while the writer's penetration method gives the same average ramming which is representative of the test-piece.

TABLE III.—*Variation of Errors of A.F.A. and B.C.I.R.A. Tests with Moisture.*

Moisture.	Green-strength. Lbs. per sq. in. A.F.A. std.	Green-strength. Lbs. per sq. in. A.F.A. D.C.	Error. Per cent.	Green-strength. Lbs. per sq. in. B.C.I.R.A. D.C.	Green-strength. Lbs. per sq. in. B.C.I.R.A. red. 1 in.	Error. Per cent.
6.89	2.42	2.23	8.0	1.18	1.84	56.0
9.43	2.74	2.62	4.5	1.54	2.36	53.0
8.37	2.52	2.44	3.3	1.54	2.30	49.3
7.07	2.49	2.23	11.6	1.30	1.84	41.6
11.90	2.44	2.39	2.09	1.66	2.18	31.3

Flow Lines in A.F.A. Test-Piece

To investigate the manner in which the sand flows under heavy blows as distinct from steady squeezing, the A.F.A. test-piece was dried and

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen.

† "Testing Foundry Sands," by W. Y. Buchanan, FOUNDRY TRADE JOURNAL, Vol. 56, p. 408.

* *Loc. cit.*

tested with the drill tester. This is described in the writer's previous Paper,* and consists of a light hardened cutter loaded suitably. This drill is rested on the surface to be tested and rotated, say, 20 times, and the sand bored out and weighed. The weight of the drill used for this test was 75.2332 gms.

The test-pieces were tested top and bottom and at every ¼ in. throughout the length, each level having four tests on the outside, four near the outside, four intermediate, and one in the centre.

Table IV.—*Variation of Errors of A.F.A. and B.C.I.R.A. Tests with Bond Strength.*

Moisture.	Green-strength. Lbs. per sq. in. A.F.A. std.	Green-strength. Lbs. per sq. in. A.F.A. D.C. R 1/32 in.	Error. Per cent.	Green-strength. Lbs. per sq. in. B.C.I.R.A. D.C. R ⅛ in.	Green-strength. Lbs. per sq. in. B.C.I.R.A. red. 1 in.	Error. Per cent.
7.07	2.49	2.23	11.6	1.30	1.84	41.6
8.80	4.62	4.10	12.7	3.06	3.81	24.5
7.70	5.60	5.44	3.3	3.31	4.87	47.2
7.40	6.86	6.79	1.0	4.56	6.37	39.8
7.10	8.00	7.05	13.0	5.18	6.625	27.9

The hardness varied in concentric rings, as is shown in Fig. 1. These were then averaged up and plotted to scale on the vertical section of the test-piece. By joining up the points of equal hardness a definite series of zones was obtained.

In the diagrams (Figs. 1 and 2) these zones are shaded with the number of lines per inch in proportion to the hardness. The double-compression test-piece (Fig. 2) was made, using the same

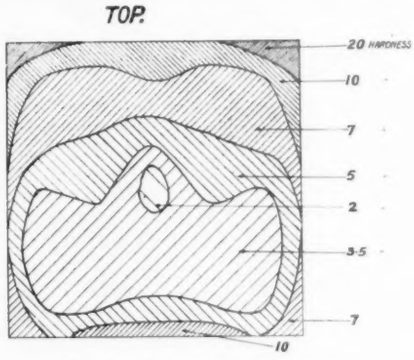


Fig. 1.—Standard A.F.A. Test—Hardness Distribution.

weight of sand. It will be observed that the A.F.A. test-piece is very irregular, and much harder than the double-compression test-piece. These diagrams clearly show the direction of flow in each case, and also the localised effect of the sudden blow as compared with the steady pressure.

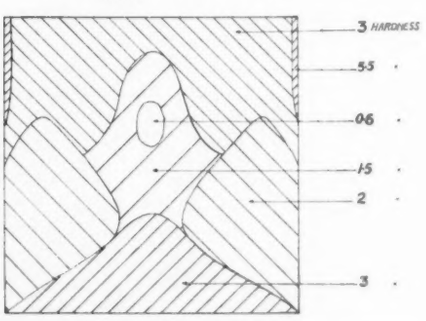


Fig. 2.—A.F.A. Test by Double Compression—Hardness Distribution.

Effect of Length of Test-Piece

Green Sand.—The tests indicated in Fig. 3 were all made by double compression on test-pieces 1⅛ in. diameter to exactly the same density, and tested top and bottom to ensure uniform ramming. All tests under 1½ in. long broke in the faces and shattered, whilst those above 1½ in. in length split diagonally with the correct fracture. The graph, Fig. 3, shows clearly that the range 1¾ in. to 2¼ in. is the correct length. Above this, the test-piece is too slim and an error is introduced which naturally increases with length. Below the correct range, the test-piece is too squat and the error rises very rapidly. The A.F.A. test-piece enters this range. The compression reading obtained on a ½ in. length of test-piece was over 16 lbs., while at ⅛ in. length it would probably read infinity. The same conclusions were obtained when testing oil-sand in the green state.

Dry Oil-sand.—Test-pieces were made to the same density by double compression in various lengths from ½ in. to 3 in. in ¼ in. stages. This work was done on 1 in. square and 1½ in. round test-pieces; the graph, Fig. 4, represents results obtained in the fifth series of tests.

All of these tests in the graph broke with the correct fracture and angle of fracture irrespective

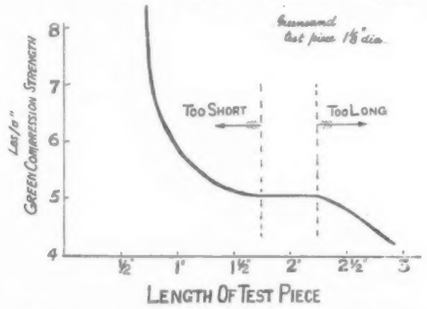


Fig. 3.—Green-Sand Tests on Test-Pieces of Various Lengths at the Same Density.

of the proportions, but the strength obtained indicates that the range close to 2 in. of length is correct.

The original explanation to be found in the American literature that the A.F.A. test-piece was squat and broke in the faces and must give a low reading, while probably correct, is not due to the proportions alone but probably the result of the bad ramming in the larger test-piece. This can readily be understood from the diagram of the hardness distribution.

Effect of Variables on Errors of A.F.A. Test-Piece

Moisture.—To test the errors in the A.F.A. test-piece the green-strengths were taken at various moisture contents, on the A.F.A. test-piece, the A.F.A. by double compression, the B.C.I.R.A. double compression, and the B.C.I.R.A. test-piece shortened by 1 in. From Table III it will be seen that the error due to the method of ramming varies from 11 to 2 per cent., while the other error due to the shape of the test-piece varies from 31 to 56 per cent.

Bond Strength.—The same set of tests was repeated for variation of bond strength, and, as

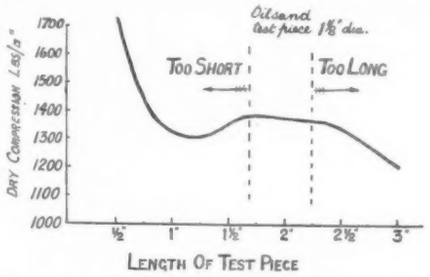


Fig. 4.—Effect of Length of Test-Piece on Dry-Strength Tests.

shown in Table IV, both the errors vary considerably.

It is thus evident that the errors are considerable and are not constant, and that they vary with moisture, bond strength, and very likely with grain size as well. All the other proper-

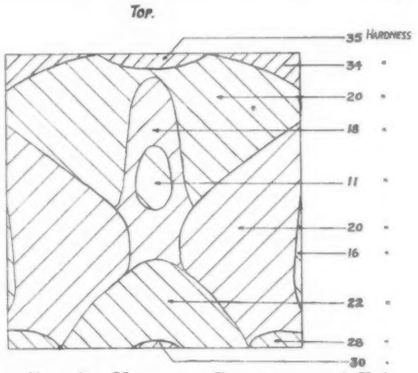


Fig. 5.—Hardness Diagram of A.F.A. Test by Improved Ramming.

ties—permeability, dry strength, etc.—show the same errors and variations in magnitude.

Importance of A.F.A. Errors

It has been said that the errors in the A.F.A. test-piece are not important—"that they are such that only a scientist can find them," to quote from at least one source, or that they are much less than the errors of the estimation. While the author agrees that some of the testing done at the moment is very poor, and probably more harmful than otherwise, there is no reason why it should be so.

Table V gives these comparison tests duplicated six times, and it will be seen that the errors in any of the duplicates are quite small,

Table V.—*Accuracy of A.F.A. and B.C.I.R.A. Tests in Duplicate. Dry Sand; Moisture 8.8 per cent.; Green-Strength in Lbs. per sq. in.*

A.F.A std. 160 gms.	A.F.A. D.C. R 1/32 in. 160 gms.	B.C.I.R.A. std. 57.39 gms.	B.C.I.R.A. red. 1 in. R. 1/32 in. 31.96 gms.
Lbs. Ozs.	Lbs. Ozs.	Lbs. Ozs.	Lbs. Ozs.
14 8	12 14	3 2	3 14
14 10	12 14	3 0	3 14
14 8	12 12	3 1	3 14
14 6	12 14	3 1	3 14
14 8	12 14	3 1	3 14
14 8	13 0	3 0	3 14
14 8 = 4.62 lbs. per sq. in.	12 14 = 4.10 lbs. per sq. in.	3 1 = 3.06 lbs. per sq. in.	3 14 = 3.81 lbs. per sq. in.
Error = 12.7 per cent.		Error = 24.5 per cent.	

* *Loc. cit.*

and there is no reason why they should be larger. The errors under discussion are five times and twelve times the error of the duplicates respectively. All other properties besides the green-strength show the same errors in the A.F.A. test.

Error due to Type of Bench used for A.F.A. Rammer

There has been a tendency recently to draw attention to the fact that an error may be introduced in the A.F.A. test, due to the different type of bench on which the ramming is done. Some benches being lighter in construction than others, it is suggested that this would introduce a serious error. The author has not found this to be the case when using very light or very heavy benches, and there is no reason why an error should be found with benches of reasonable construction. The bench used in all these tests is 1 in. thick, feather and grooved wood on top and covered with sheet steel.

Ramming the test on a heavy concrete floor reduced its length by $\frac{1}{32}$ in. and the permeability by 12 per cent., at the same time increasing the green-strength by 11.6 per cent. By removing the rammer to an obviously unstable bench, the correct test was exactly duplicated. There is, however, really no reason to consider ramming on a concrete floor or a plywood box.

Uniform Ramming of A.F.A. Test-Piece using Drop-Weight

It has been said in favour of the A.F.A. test that it can be made by double-ended ramming, and so presumably eliminate the first of the defects, namely, the uneven hardness of the test-piece. This proposal is worth examining, for something of the kind is badly wanted, especially in the event of the A.F.A. test being universally adopted. From Table VI it will be seen that double-end ramming is best done by two blows with $\frac{1}{16}$ in. distance piece under the A.F.A. tube and one blow without.

The first observation made was that the so-called double-end rammed test-piece was shorter and therefore denser, and to make it the correct length the weight of sand had to be increased. The hardness figures show this test-piece to be much more uniform than the standard A.F.A. test-piece, at the same time giving higher green-strength and lower permeability of the order of 17 per cent. increase in strength and 27 per cent. reduction in permeability.

It is true that the making of the A.F.A. test-pieces to something approaching uniform hardness would remove one of the errors, but it is thought that very few, if any, of its users in this country would notice the absence of this error. On the other hand, it could be adopted without mental effort, and would make the A.F.A. and the *index of ramming* methods comparable in the same terms.

The hardness diagram (Fig. 5) of the A.F.A. test-piece made by this improved method shows a hardness distribution very much the same as the double-compression method used in the *index of ramming*, except that in the improved drop-weight method there is a tendency to localised hardness on the top, to be expected where the compressing force is applied in the form of blows instead of a steady squeezing force.

It is interesting to note that, where the A.F.A. test-piece is rammed by the drop-weight method as described, so as to produce an even distribution of hardness, it gives a harder test-piece than the same weight of sand rammed by compression. For example, with both test-pieces 166.5 grms. and the same hardness top and bottom, the drop-weight rammed test-piece is harder, has higher strength and lower permeability.

Further proof is afforded by Table VII that the Dietert A.F.A. test only measures skin hardness, as it does not show any difference between these tests.

Table VI.—*Improved Running of A.F.A. Test-Piece and its Effect on Tests.*

Method of making test-piece.	Standard A.F.A. 2 in. 3 blows.	A.F.A. 2 in. 1 blow with $\frac{1}{16}$ in. 2 blows without.	A.F.A. 2 in. 2 blows with $\frac{1}{16}$ in. 1 without.
Weight, grams.	170	171	171
Green-strength. Lbs. per sq. in. ..	5.73	6.67	6.74
Permeability No...	77	68	56
A.F.A. hardness .. .. Top ..	84.0	84.3	82.2
A.F.A. hardness .. .. Bot. ..	77.9 } 81	80.8 } 82.5	82.3 } 82.2
Penetration. Mms. .. Top ..	16	15.5	16
Penetration. Mms. .. Bot. ..	17 } 16.5	16.0 } 15.7	16 } 16

Application of Index of Ramming Method

It is suggested that the Index of Ramming be used as the standard ramming, since it is based on first principles; that it be made additional to the A.F.A. method, as it seems that, right or wrong, the general tendency is to follow the majority; finally, that the A.F.A. test-piece be made uniform in hardness as described.

Neglecting for the moment the defects in the A.F.A. test as now made, the variation of flowability of a sand with changes in moisture, clay, and grain size or distribution, is always confused in the A.F.A. results with the effects due to the moisture, etc., alone. Thus, the difference between the A.F.A. and Index of Ramming gives the flowability in such terms as green-strength, etc., which are more readily understood. The Index of Ramming method will, of course, give the true effect of the variable under consideration. One recent example to illustrate this, for instance, is F. Hudson's work at high temperature which was carried out on the A.F.A. test-piece, and led him to the conclusion that coal-dust, sawdust, etc., were beneficial in reducing expansion. The Index of Ramming method on the 1¼ in. double-compression test-piece showed that this was not correct, and the wrong conclusion is entirely due to the variation of his 2 in. test-piece due to flowability.

The 2 in. diameter test-piece is unsuitable for this work, owing to the long time lag in heating from outside to centre. The above is the only reason why the opposite conclusion was reached, except that the work by Index of Ramming was carried out in greater detail and more accurately.

A.F.A. Standard Method and Constant Index of Ramming

Moisture.—Fig. 6 shows that in both the Dietert skin hardness test and the author's penetration hardness test, the A.F.A. test-piece shows less tendency to harder ramming as the moisture decreases. This is due to the decrease in flowability of the sand with decrease in moisture. Dietert's hardness number was always taken on five tests top and five tests bottom for the average, while the penetration is the average of one top and one bottom.

The penetration hardness, as shown by Fig. 7, is more reliable as a measure of ramming density,

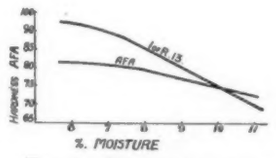


Fig. 6.—Moisture related to A.F.A. Hardness.

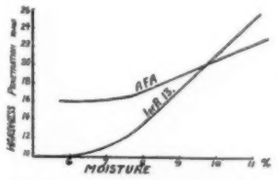


Fig. 7.—Moisture related to Penetration Hardness.

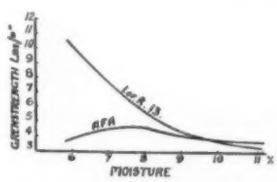


Fig. 8.—Moisture related to Green Strength.

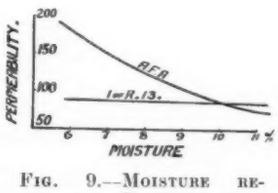


Fig. 9.—Moisture related to Permeability.

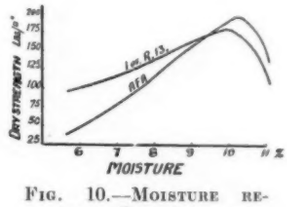


Fig. 10.—Moisture related to Dry Strength.

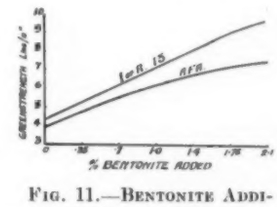


Fig. 11.—Bentonite Addition related to Green Strength.

(Graphs based on figures derived from the A.F.A. Test and Index of Ramming 13.)

Table VII.—*Skin Hardness Effect of Dietert A.F.A. Method.*

A.F.A. test-piece.	Weight of sand. Grms.	Green-compression. Lbs.	Dietert's hardness.	Author's penetration test. Mms.
2 blows $\frac{1}{16}$ in. 1 blow without ..	166.5	7.0	Top 83.8	14.5
			Bot. 83.8	14.7
Double compression, R $\frac{1}{8}\frac{1}{2}$ in.	166.5	6.0	Top 83.0	16.0
			Bot. 83.4	16.0

but the degree of reliability in the case of the Dietert hardness number has been enhanced by taking the average of ten readings in each test-piece as compared with one penetration test on each test-piece. According to the author's experience, single tests by the Dietert tester are not reliable for this purpose, nor are several tests if taken on the same part of a test-piece.

Variation of Green-Strength with Moisture.—The A.F.A. test shows very little variation in the green-strength over the entire range of moisture while the *index of ramming* test shows a very high strength at low moisture, and slightly lower strength at high moisture. The effect of flowability on the A.F.A. test-piece is here illustrated by the difference between the graphs of Fig. 8. Thus, at 6 per cent. moisture, the flowability is responsible for a 60 per cent. drop in green-strength, while at 11 per cent. moisture the strength of the A.F.A. test-piece is 14 per cent. higher, due to flowability. On the other hand, the index of ramming graph gives the true effect of moisture on the green-strength.

Permeability.—In Fig. 9 the A.F.A. test shows a 100 per cent. increase in permeability at 6 per cent. moisture, and a 16 per cent. drop at 11 per cent. moisture, which is due to flowability. The actual effect of the moisture on permeability is

nil in this case, as shown by the index of ramming graph.

Dry-Strength.—Also in Fig. 10 the A.F.A. test shows a drop of 75 per cent. in dry-strength at 6 per cent. and a rise of about 10 per cent. in dry-strength at 10.5 per cent. moisture, due to flowability. The effect of moisture is in general the same in both cases, namely, a maximum dry-strength about 10 per cent. moisture. There is a 60 per cent. drop in the A.F.A. test at 6 per cent. moisture, due to flowability.

Bentonite and Green-Strength.—The effect of bentonite additions is shown by Fig. 11 to increase the green-strength considerably, and the effect of flowability on the A.F.A. test causes it to register a progressively lower strength as the addition increases. The flowability reduces the green-strength by 10 per cent. at 0.35 per cent. bentonite and 20 per cent. at 2.1 per cent. bentonite. This fact should be kept in mind when evaluating addition of various clays in practice.

Effect of Coal-Dust on Green-Strength.—The main effect of the addition of coal-dust to this relatively coarse sand under examination will be that of variation of grain size. The *index of ramming* shows in Fig. 16 a distinct maximum strength at about 1 per cent. coal-dust addition. This critical stage in the mixing of materials of different grain size is of some practical importance, and has been referred to in the B.C.I.R.A. literature recently. The effect of flowability on the A.F.A. test is to reduce or counteract this effect.

Effect of Coal-Dust on Permeability.—In the case of permeability (Fig. 17) the *index of ramming* method shows little effect with the increase of coal-dust, while the flowability change causes 32 per cent. increase in permeability at 1½ per cent. coal-dust addition.

Effect of Coal-Dust on Dry-Strength.—The *index of ramming* method shows a maximum dry-strength at 1½ per cent. coal-dust addition, while the A.F.A. test shows little change throughout the range (Fig. 18). The flowability effect at 1½ per cent. coal-dust addition has resulted in a drop in dry-strength of 33 per cent.

Effect of Coal-Dust on Hardness.—The hardness graphs (Figs. 19 and 20) show similar curves, but the increase in hardness at about 1 per cent. addition is not very pronounced in the A.F.A. test, and it is also more clearly shown by the penetration hardness test (Fig. 20).

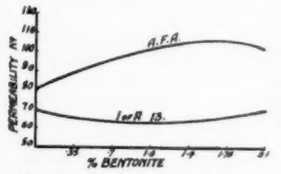


Fig. 12.—Bentonite Addition related to Permeability.

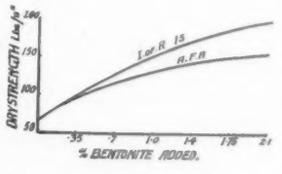


Fig. 13.—Bentonite Addition related to Dry Strength.

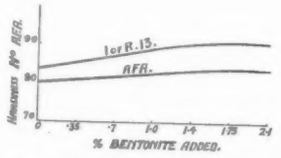


Fig. 14.—Bentonite Addition related to A.F.A. Hardness.

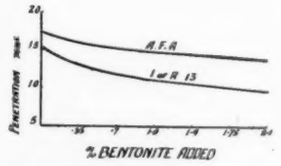


Fig. 15.—Bentonite Addition related to Penetration Hardness.

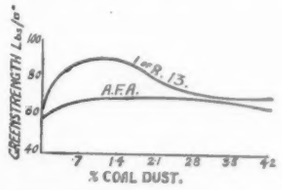


Fig. 16.—Coal-Dust related to Green Strength.

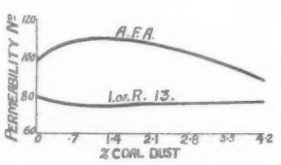


Fig. 17.—Coal-Dust related to Permeability.

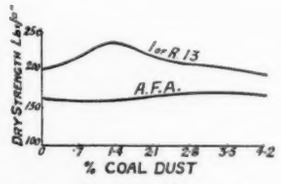


Fig. 18.—Coal-Dust related to Dry Strength.

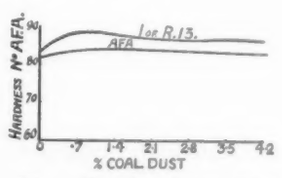


Fig. 19.—Coal-Dust related to A.F.A. Hardness.

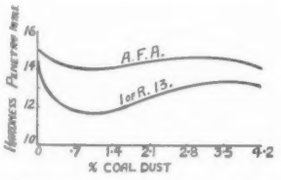


Fig. 20.—Coal-Dust related to Penetration Hardness.

(Graphs based on figures derived from the A.F.A. Test and Index of Ramming 13.)

Bentonite and Permeability.—The A.F.A. test shows in Fig. 12 improved permeability with increased bentonite which is evidently due entirely to decrease in flowability. At constant *index of ramming* the opposite conclusion is reached.

Variation of Bentonite on Dry-Strength.—A similar conclusion is drawn from Fig. 13 as in the case of green-strength, namely, that the flowability is responsible for a steady increase in the difference between the tests. With no bentonite addition, the flowability difference is zero, while at 2.1 per cent. addition the true dry-strength has been reduced 21 per cent. Thus the addition of bentonite to this foundry sand produces higher green-strength, lower permeability, higher dry-strength and higher hardness than is shown by the A.F.A. test-piece, and this will occur in practice where the ramming is not kept exactly the same as in the A.F.A. test. When choosing clays on their merits, they should be evaluated by the *index of ramming* rather than the A.F.A. test.

Bentonite Addition.—The hardness tests (Figs. 14 and 15) show that as the bentonite addition increases the difference between the graphs increases. The rise in hardness is offset in the case of the A.F.A. test by decrease in flowability.

Deformation under Compression

This property is really better described as plasticity. Recently this was brought to American notice by an excellent Paper by Dietert in A.F.A. units. The idea is not new, however, as several German workers had developed their own test eight or nine years ago. At the same time, quite extensive tests and experiments were carried out by the B.C.I.R.A., in which Skerl measured this property in compression and worked a long time to correlate the deformation to moisture.

The compression frame shown in Fig. 21 was made with a micrometer screw to carry the work on at the time. This works very well, and the method is as follows:—Having taken the maximum compression reading, the balance is pushed down, and a wooden test-piece is put in position. The screw is then run back until the balance gives the correct maximum compression reading again. The difference in length is thus read off in thousandths of an inch. Now, if a set of tests is loaded by increasing amounts and the deformation measured, then a graph of load against deformation plotted, a stress-strain graph is obtained, and from this the yield point obtained.

This yield point is less than the maximum stress, and Dietert claims that this is the important test, being the load at which swelling occurs in green-sand moulds. In order to measure this quickly, a small indicator was fitted to the spring balance, which was also fitted with a levelling plate. This levelling plate under the balance is simple, effective, and perhaps better than the universal head recently put forward.

The yield point which is noticeably low in oil-sand in the green state is shown by the indicator, as the deformation is slow and steady up to the yield point, when it moves rapidly to the point of fracture. The load should be read at the yield point, but this might be better done by clamping a loose pointer or clamping the balance while watching the movement of the small attached indicator. The writer would like to put this suggestion forward, as the apparatus

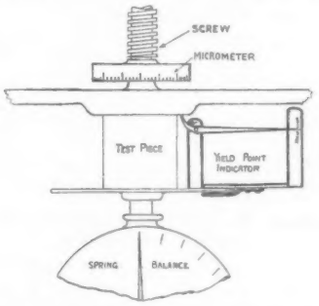


Fig. 21.—Yield-Point Indicator.

can be made very cheaply and added to the existing recommended apparatus. The green-strength as a figure is not very helpful.

Mr. J. Hird asked the Committee on Sands some time ago why a sand with not very good strength should give a better draw in moulding than one with a good green-strength. The lack of plasticity is the answer, and this would be shown in the above test.

The green-strength should be superseded by the index of strength or, as Dietert calls it, resilience. This word is misleading, as the dictionary says this means "springiness," whereas in sand it is a case of plasticity, resilience being entirely absent. This index or resilience is a number which is the product of maximum strength and deformation in thousandths, and is entirely adequate.

Recommendations

(1) The A.F.A. test apparatus be made with the tube free to move downwards during ramming, and so produce a test-piece as nearly uniform as possible.

(2) That the Index of Ramming method be added to the A.F.A. test.

(3) That the deformation test be done in the existing recommended spring balance, by the fitting of a micrometer disc on a good make of square-thread screw.

(4) That the yield point indicator as described be added to the compression balance.

The Shotts Iron Company, Limited, has placed a contract for the erection of additional kilns at its Roslin brickworks in an effort to increase the output by 50 per cent.

Patternmaking in Relation to the Foundry*

By T. R. HARRIS

The subject of patterns is one that always calls forth a measure of controversy when considered by a meeting of foundrymen, and a diversity of opinion is often apparent between the members of the different sections. Often the criticisms of the moulder are justified, while many of the complaints of the patternmaker are not undeserved. The business of the foundryman is to produce saleable castings. Unless supplied with the most efficient aids to production the cost of his castings will be relatively high. Among the most important of these aids to production are patterns. In a shop handling repetition and semi-repetition work these are of the greatest importance. Often unsuitable patterns are supplied from outside sources. Even the attached patternshop—if run as a separate department—may sometimes supply inferior pattern equipment. That this is not ideal must be apparent to all foundrymen. Actually the patternshop should be considered as the toolroom of the foundry. The productions of the patternshop, unlike other woodworking shops, are not finished articles.

Patterns are not ends in themselves but means to an end. It therefore follows that their cost is relative to that of the finished casting. The cost of castings and not patterns should always be the major consideration when patterns are being planned. Both departments should thus work in the closest harmony, and not as separate units. A little extra expense on a pattern initially may mean the considerable reduction of the cost of production of the castings. There is thus the greatest need for a sympathetic understanding of the needs of the foundry by the patternshop. This is a strong reason for the single control of both departments by one executive.

The quality of patterns should conform to some standard as to materials used and finish applied. Obviously, a higher class of pattern is required for a casting which is for semi-repetition work than for a jig for the same component. It is in handling work of the latter type or of a similar nature that the patternmaker can exercise ingenuity. A cheap pattern may be produced which takes longer to mould, yet results in a cheap casting when all the factors are considered.

After a decision has been reached regarding moulding methods to be adopted, the construction of the pattern should receive careful consideration. This is very important, as a pattern that is indifferently constructed is always a source of trouble to the moulder.

Making a Circular Stand

Fig. 1 illustrates a circular stand which is moulded in a three-part box, joints in the mould being taken at A and B, C and D being the pattern joints. Fig. 2 illustrates alternative methods of construction. The left-hand view shows a pattern made very quickly and cheaply. Portion E is made of one thickness of timber, while F is made of two thicknesses crossed. The body portion G consists of two ends H, H_1, with pieces nailed between them. The defects of this pattern will be at once apparent to foundrymen. After a few moulds have been made, the top flange E will invariably buckle, because of the varying conditions in the foundry. The dowels J will then tend to be tight and difficulty experienced in removing the pattern, while the flange will most certainly be oval instead of circular. Portion F, made of two thicknesses, may not exhibit the tendency to buckle so readily, but the shrinkage across the grain of each piece will cause overlapping, which is not conducive to a good draw. The body G represents very bad practice; not only is the pattern flimsily constructed, but the grain which is exposed on H, H_1 quickly absorbs moisture and causes these parts to assume a different shape from the lagging I, again resulting in a bad draw.

The right-hand half of Fig. 2 shows the flange K built in a manner to avoid shrinkage and buckling. The lower sketch shows the method adopted. Two pieces L and M, half the thickness of the flange, are fastened together with the grain crossed. Around L six segments are fitted and secured through M as N. Around M and on to N six other segments O are fastened. This flange will not suffer from the defects of the previous one, E. Instead of dowels, as at J, spigots are turned on the body portion which fit the recesses P and P_1 in the flanges. The bottom portion Q is built similar to K with the addition of a row of segments recessed into it forming the large radius R. The body is made by securing pieces S to the ends T, T_1, which makes a strong pattern, especially when shouldered as shown. Although taking longer to make in the first instance, the right-hand construction would be the cheaper pattern if a number of castings were required.

A Gear Case Pattern

Fig. 3 illustrates two methods of "boxing up" a pattern for a gear case. The right-hand half shows the top and bottom plates A and B cut to size with pieces C secured between them; this construction is not to be recommended because of the overlapping which occurs after repeated using. The left-hand half is a better method; plates D and E are made as shown and pieces F fastened around them. The grain of these pieces being vertical in the mould, a clean draw is always ensured.

Cast Gears

Cast gearing is not used as extensively to-day as formerly, yet sometimes wheels with cast gears are required. For medium-sized wheels from which a fair number of castings are required, a full pattern is an advantage unless a wheel moulding machine is available. The usual method of making these patterns is shown in Fig. 4, and consists in dovetailing teeth on to a laminated body. The difficulty of cutting dovetails in a body built of segments, together with the fact that invariably after a time even built-up jobs shrink and cause overlapping, suggested the following construction. The body A is built and turned $\frac{1}{2}$ in. smaller in diameter than the diameter at the bottom of the teeth. A number of hardened dovetails are then prepared and secured as at B; the centre-lines of which correspond to the pitch. Other dovetails are then fitted between those on the body as at C. The whole is then trued in a lathe to the diameter of the bottom of the teeth. The teeth are then secured to the dovetails C. This method always ensures the long grain in the direction of withdrawal and is far superior to orthodox practice, D.

A Question of Taper

After construction, taper is the next most important consideration in relation to the foundry. Here the patternmaker can be helpful. The engineering department often expects castings with the minimum of taper, while the foundry desires the maximum. Fig. 5 shows scrap views of the foot of a bracket, typical of many castings. The machine shop prefers face A to be practically square with face B, and the boss C parallel with face A. To accommodate the machine shop without prejudice to the foundry is the task imposed on the patternmaker. This can be accomplished by imparting only a slight taper to the foot at face A, while face D can receive a generous amount, as can also the ends F. Likewise the boss needs only the slightest taper on face C, but the ends F can be amply tapered. Rib G, beside being well tapered, can have the top nicely rounded, which assists the draw considerably.

Fig. 6 illustrates a case where a maximum of taper is necessary to ensure a good top lift. To obtain this and maintain the measurement A—which makes a joint—it is necessary to taper as shown. This restricts the insertion of bolts at a number of places. Instead of neglecting the foundry by eliminating the taper or ignoring the machine shop and causing the nut seats to be "knifed out," a compromise is made. Considerable taper is imparted at C, while at the places where the nuts seat the pattern is relieved as at D.

Air-Cooled Cover Casting

Fig. 7 is a part-section of an air-cooled cover. The face A is required square and the wall B of even thickness throughout. The fin portion is cored out and the plate of metal C cast down. To obviate the necessity of making a core for the interior or imparting taper to face A a special construction was adopted for the pattern. A view of this is shown in Fig. 8, E being the core prints for the fins. The fillet at the junction of A and C, Fig. 7, is cut from the bottom, F, Fig. 8. A recess is made all around as at G, with the wall H of a generous taper. Portion I suits this taper and is dead square on the inside. On moulding, the four pieces I on each side of the pattern lift with the top and are then drawn away separately. The sketch shows the method of making the corner fillets. These are cut from the two sides, the ends being plain. This method of pattern construction obviates a core, and taper on the faces of the casting.

Fillets

Fillets are of great importance in foundry work. Only on one-off jobs should they be omitted and a blue pencil line drawn to indicate to the moulder that a fillet is required. In core boxes it is sometimes difficult to cut fillets, but means should be devised to overcome this. Especially if the fillet define a thickness, it should be incorporated in the pattern equipment.

Fig. 9 shows a case where a casting was scrapped because the patternmaker omitted the fillet, expecting the core maker to file the core to shape, which he failed to do. Moreover, the moulder, when assembling, did not notice anything wrong, as this particular place was in the top part of the mould and could not be seen. Whenever practicable, fillets should be cut from the solid timber, as those of the loose variety soon deteriorate in use. If it be impracticable to cut from the solid, then fillets should be "let in," as shown in Fig. 10.

Loose Pieces

Loose pieces of a pattern are always a problem. It is sometimes possible to eliminate them by a modification of design. Where possible this should be encouraged, as loose pieces often get misplaced or lost, resulting sometimes in waster castings. The securing of loose pieces by nails is a very unsatisfactory method for standard work. The best results are obtained from dovetails. These should be of aluminium to obviate sticking and consequent tearing of the mould. Sometimes the use of dovetails is impracticable because the thickness of the loose piece and that of the space into which it must be withdrawn are nearly the same. Fig. 11 illustrates this point. The boss is $\frac{5}{8}$ in. and the foot of the casting only

* A Paper read before the Bristol Section of the Institute of British Foundrymen.

$\frac{3}{4}$ in. This prohibits the use of a substantial dovetail.

A method found satisfactory for such cases is shown in Fig. 11, A being one of two skewers made of $\frac{1}{8}$-in. dia. wire fixing into a brass dowel cup B. The use of the dowel socket acts as a location for the skewer and also protects the hole from wear by continual use.

Dowels

The next consideration is dowels. For one-off jobs wood dowels may serve, while for patterns from which a few castings are required the brass plug and socket type are suitable. Standard work should be fitted with malleable plate dowels. There are jobs where even these are not ideal. A pattern as in Fig. 12, when of fairly large dimensions, illustrates the difficulty of assembling in the foundry by plate dowels. To overcome this difficulty a thin plate of aluminium, A, can be secured to the mid portion which fixes into a recess B, while hardwood pins of ample size C can fix into holes in D, which enables the moulder easily to locate the top flange.

Core Prints and Boxes

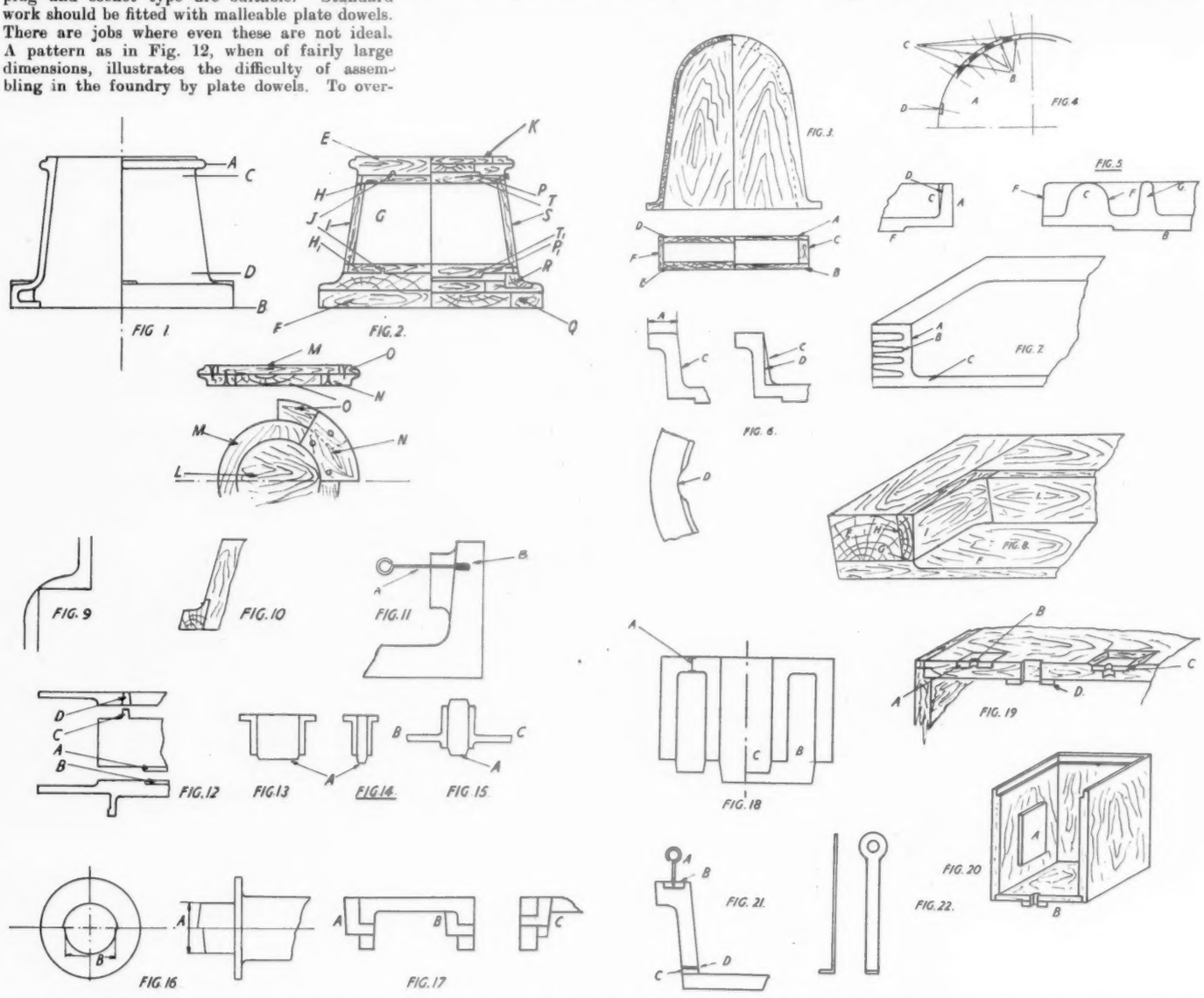
Core prints and core-boxes are of great importance in foundry work. Unfortunately, one still finds examples of patterns and core-boxes which reveal that the person responsible for their production did not consider the foundry. As a rule, especially for dry-sand work, core prints should be made bigger than the core-box to allow for the expansion of the particles of sand on drying, and the coat of blacking given to both mould and core. For larger cores, in which a cast-iron grid is used, the core-box should be made an amount smaller to permit of the expansion of the grid on the drying of the core. For high-class work, the core-boxes should always be shaped to the print to avoid filing of the core by the moulder before its insertion in the mould.

The following examples illustrate the subject of core prints from the moulder's point of view. Figs. 13, 14 and 15 illustrate portions of jobs which require a core, as at A, in each instance. Fig. 13 is a case in which the core is of large diameter and short, giving a very large surface on which to rest easily; consequently a shallow print will be suitable for this, being only required to locate the core in its correct position. In Fig. 14 the core is of small diameter and long, and is not only required to be located, but held in position in the mould. To do this it is necessary to have a long deep print so that the core can be firmly held upright by it. To use or not to use top prints is a consideration often facing the patternmaker. Many play for safety and put on one.

Top Prints

Top prints can become sources of trouble when closing a mould; however, in some cases, they are indispensable to ensure the correct position of a core. In Fig. 14 a top print is not required, as the moulder can easily test the centrality of the core by the outside of the mould before closing. In Fig. 15 this is not possible, as most of the boss through which the core passes is in the top of the mould, the joint being along the line BC. Fig. 16 shows another type of core print often referred to as a "core seat," it being jointed as the pattern, part in the bottom and part in the top boxes. When such a job is assembled, there is a danger of a "crush" taking place, to guard against which the moulder eases the top "seat" to clear the core. For repetition work this scraping of the mould should be unnecessary; the pattern should be printed to avoid this. The illustration shows a round seat with top clearance. It must be remembered, when placing enlarged prints on a pattern, that it is only on the width and not the depth that clearance is required. If made with clearance on top, a "lift" of the core would result, thus throwing it out of centre. Distance A in Fig. 16 should be the same as distance B.

Another type of print is shown in Fig. 17, and is of the "pocket" variety. A hole is required through a wall of metal which occupies a vertical position in the mould. To accomplish this a print is extended from the required position to the mould joint, which allows of the insertion of the core. For one-off jobs a plain core would be inserted and built over by the moulder. For repetition work a core should be made which stops out the print portion as well. A shows the



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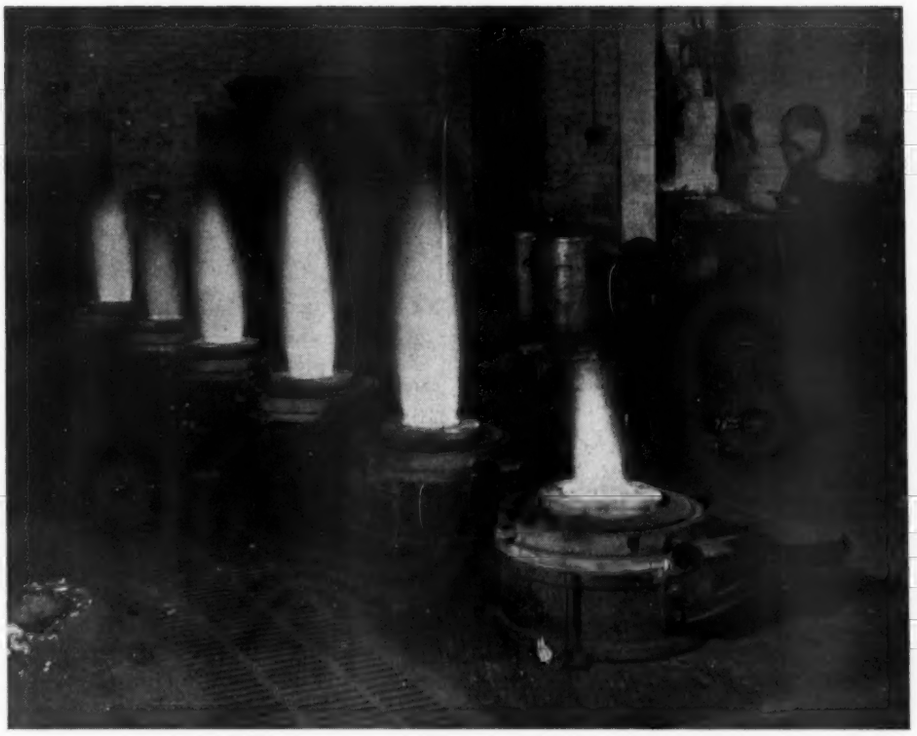

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correct position of the print, the top of which touches the top box. If made as at B, and it was not nailed to guard against "lift," it would float as shown in C.

Eliminating Studs

Chaplet elimination is closely allied to the subject of core prints, and much could be done in the patternshop to aid the foundry. One example only will be given. Fig. 18 shows a portion of a casting, the remainder of which decides that it is cast in the position shown. The left-hand view shows the original coring arrangements, the right-hand view that ultimately adopted. It will be seen that the first method needed a chaplet at A to keep down the core. Although not detrimental to the job, seeing it had not to withstand hydraulic pressure, the use of chaplets was considered an unnecessary expense both in cost of chaplet and time in securing them. The method shown in the right-hand half of the figure shows core B being kept down by core C, this in turn being kept down by the top box.

Rapping and Lifting Plates

Rapping and lifting plates are an essential to good patterns. Fig. 19 illustrates a section through a pattern fitted with these necessary protections. A shows an orthodox plate, which is not ideal, as no hole is provided in the woodwork underneath the plate to receive the rapping bar. Also, if on a joint, the burr B, which is occasioned by the rapping, causes the top half of the pattern to "ride." C shows a better arrangement; under the hole in the plate is one of larger diameter, which allows of the bar being inserted without damage to the woodwork. C also illustrates the plate recessed $\frac{1}{4}$ in. in the pattern, which accommodates the "burr," so keeping the joint true.

Fig. 20 illustrates a different type. In this case the top of the pattern is loose and the rapping is done on the sides on plates A. Lifting in Fig. 19 is accomplished by means of a key, which is given a quarter turn after insertion through plate D, which is secured to the underside of the joint. The same method is used in Fig. 20, only a longer key is used, and the pull is against the bottom as at B, instead of the top —which in a deep pattern may part from the main body.

Fig. 21 is a section of a soleplate, A being a method for withdrawing the pattern. This is a screwed bar tapped into a plate B. A better method is to use a key, as in Fig. 22, inserted in the slot C, which is protected by plate D (Fig. 21). In this case the pull is in the direction of withdrawal of the pattern.

There are many more aspects of this question of patterns in relation to the foundry which have to be omitted from this Paper, such as patternplates for hand and machine moulding, metal patterns, plaster patterns and other relevant topics.

Cost to Industry of A.R.P.

The Federation of British Industries has issued a protest against the Government's decision as to what types of expenditure on air raid precautions will be allowed as a business expense for income-tax purposes. The concessions are regarded as entirely inadequate, and the Federation asks that the question should be reconsidered. It is pointed out that the decision of the Government means that none of the more costly types of expenditure—such as the strengthening of the structure of buildings or the provision of shelters—is admissible as a business expense. Such expenditure is not admissible under the existing law, but to meet an emergency, emergency measures are necessary. Further, the decision will act as a deterrent to the fullest development of A.R.P. measures, and represents a heavy burden upon industry for providing a national service.

Examination of Some Casting Defects

By G. H. PIPER.

Casting defects in iron foundries may be conveniently classified as arising from (*a*) condition of the metal and (*b*) moulding conditions. The latter are more common, and defects of this type attributable to moulding sand frequently arise when production has been increased by the adoption of moulding machines in place of hand moulding. Defects due to moulding sand include blowholes, scabs, pinholes, veining and burning-on, and it is frequently difficult to ascertain the property of the sand responsible for a particular defect, owing to the lack of technical control over the sand.

Pinholes and small surface cavities are a frequent defect and may be due to (1) moulding sand which is relatively impermeable to the gases produced when the metal is poured into the mould, these gases originating from the water, coal-dust or core binder in the sand; or (2) sand grains washed from the mould surface by the metal, or slag particles. Such cavities are much larger than the particles producing them owing to the contraction of the metal during solidification.

Revelation of Sand Grains in Blowholes

In practice it is often difficult to distinguish between these two types, as the sand grains or slag particles responsible for the second type appear inconspicuous against the surrounding metal of the cavity. With considerable experience in the examination of these defects some assistance in deciding the type of defect is obtained by noting the location, shape and surface reflection of the pinholes. Defects due to dirt in the metal usually are on the upper side of the casting, while holes due to mould gases may be associated with local over-ramming of the sand, as on machine moulds with considerable pattern relief. In the latter case the shape and surface reflection of the pinhole serve to show whether the mould gases responsible for the defect arise mainly from high moisture content or excessive coal-dust.

In some cases the presence of sand grains in a cavity is readily apparent, but in the large number of cases it is found that detection is difficult owing to the metal and the burnt sand grains being of similar colour. The surface reflections from the metal and sand grains are also readily confused, especially under a high-power microscope. In the author's experience the examination is best made with a strong magnifying glass (such as is used for the examination of textiles) in preference to the microscope, owing to the more natural appearance and depth of focus.

In the method developed by the author for the examination of these defects the cavity is examined in this way after application to it of a few drops of the following solution:—Copper chloride, 50 gms.; ethylene glycol, 20 c.c., and water, 100 c.c. The application of this solution results in the rapid development of a red coppery coating on the cast-iron surface, whilst it is without action on sand or slag particles. Under magnification the latter show up in strong contrast to the reddish-coloured walls of the cavity and are readily detected.

In many cases the pinhole connects with a large-sized cavity under the surface, and the examination is facilitated by breaking the casting so as to expose the cavity. The solution is applied, avoiding air bubbles, and the defect examined as soon as the red-coloured coating has developed. The glycol functions by promoting a thin, even coating, and in its absence the coating tends to deposit at isolated spots on the metal.

With the type of the pinholes established, alterations in the moulding practice may be tried out in order to eliminate them. Lack of permeability of the moulding sand may be corrected by the various established methods, the choice of which depends mainly on individual and economic factors. These corrective methods, briefly, are: the use of a desilting plant; softer ramming; combining the moulding sand with a more open silica sand of appropriate grain size, and by keeping the moisture and/or coal-dust percentage as low as practicable.

Mould Gas Pressures

The control of the coal-dust percentage is not carried out so readily as the moisture percentage. The mould gases from the coal-dust appear, however, to be of greater importance in causing blowholes than the gases formed from the moisture present. This has been shown by Maske and Piwowarsky* in casting experiments in which molten iron was poured into a mould, and the actual back pressure of the mould gases tending to form blowholes was measured. Their prepared moulding sand containing 6 per cent. of coal-dust and 10 per cent. of water gave a maximum pressure of 23.0 cms., without coal-dust 3.6 cms., and if the mould made from the prepared sand was dried out, the pressure developed was 12.6 cms. The back pressure developed is thus considerably more influenced by the coal-dust percentage than by the moisture percentage, and it is shown that the effect of the coal-dust is due to the gases evolved and only to a slight extent to the decrease in gas permeability produced by the fine coal-dust particles. In view of their interest some further figures obtained by these workers are given below.

Type of sand.	Coal-dust. Per cent.	Water. Per cent.	Pressure developed. Cms.
"Prepared" sand	6	10	23.0
	10	10	30.1
	14	10	36.0
Milled sand	0	10	2.8
	4	10	21.1
	6	10	28.6
	8	10	34.0

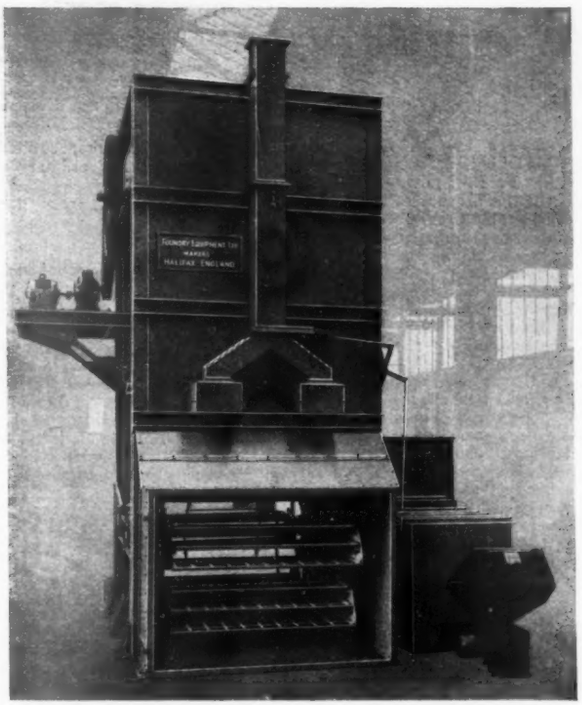
Defects from Bad Shanking Practice

Pinholes caused by sand particles washed off the surface of the mould by the flow of metal are of the second type, the sand usually being washed from the bottom of the ingate or runner, which may be examined for confirmation. The dry strength of the moulding sand at these parts is an important factor, and usually increases with the moisture and coal-dust percentages, the requirements for high dry strength thus being opposed to the requirements for a high permeability. The casting should not be poured from the top, if possible, but even a well-designed runner correctly situated at the side of the casting does not always remove trouble from sand erosion, and in some cases it is advantageous to mould the ingate and runner in core sand as a separate part and to bake the latter in the usual way as for a core. Holes due to slag in the metal are also met with, and apart from the obvious origin of dirty metal from the cupola, such slag may come from a sand lining of a ladle or hand shank. The effect appears to arise when the hand shank is allowed to cool between pours, and is due to the iron oxide left in it fusing on to sand grains of the lining and separating with the latter on cooling; the resulting slag particles pass into the mould at the next pour.

Crane-Making Business Acquired

Henry Lees & Company, Limited, engineers, of Glasgow, have acquired the business of John Grieve & Company, cranemakers, of Motherwell, which was founded in 1878. Henry Lees & Company will continue manufacturing their own specialities in addition to cranes. The staff and workmen of John Grieve & Company are being retained.

* FOUNDRY TRADE JOURNAL, Vol. 40 (1929), p. 233.



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The Week's News in Brief

Trade Talk

THE JUBILEE of the Scottish Brassmoulders' Union is to be celebrated on May 7.

DEMAG A.-G., Duisburg, are paying a dividend of 8 per cent. on account of 1937, against 7 per cent. in 1936.

THE VULCAN FOUNDRY, LIMITED, Newton-le-Willows, Lancs, has secured an order for 25 steam locomotive boilers for India, including 15 for the Bengal-Nagpur railway.

AN ORDER for a tanker of 14,500 tons has been received by Sir James Laing & Sons, Limited, of Sunderland, for Norwegian owners. The engines will be built by W. Doxford & Sons, Limited, Sunderland.

ALEXR. WILSON (ABERDEEN), LIMITED, engineers and ironfounders, of Aberdeen, are to supply machinery for cutting and polishing the stones which will be used in the erection of the new Union of South Africa Government offices in Johannesburg.

THE BENONI STEEL FOUNDRY (S.A.) has increased the floor space of its foundry and has erected an additional 2-ton capacity electric furnace of the Héroult type. Additionally a 5-ton overhead electric travelling crane and a Tilghman sand-blasting unit have been installed.

MR. WILLIAM HERITAGE was killed, and Mr. Simeon Hartill was injured, as the result of an accident in the casting pit at the foundry of Charles Akrill & Company, Limited, West Bromwich, last week. They were releasing the clasps from a casting casing in which was a large roll weighing between 15 and 20 tons when the roll suddenly toppled over on to the men.

Personal

MR. BEN HIRD has been appointed foundry manager of the Tubal Cain Foundry & Engineering Works, Cardiff.

MR. F. GUDGEON, works manager of the International Combustion, Limited, Derby, has been elected President of the Derby Society of Engineers.

MR. DAVID L. COOPER, chief clerk of the Carron Company, Falkirk, has received a presentation from the staff of the engineering department on the occasion of his marriage.

MR. ALAN P. GOOD, who was a director of Andrews Toledo, Limited, up to the time of its acquisition by Darwins, Limited, has been elected a director of the latter company.

PROF. J. H. ANDREW, Dean of the Faculty of Metallurgy of Sheffield University, has been elected President of the Sheffield and District branch of the Institute of British Foundrymen.

A PRESENTATION took place at the works of Pneulec, Limited, Smethwick, last Thursday, to mark the occasion of the forthcoming marriage of Mr. W. Warmington, who has occupied the position of sales manager for the past 15 years. As his fiancée was, until recently, also a member of the staff, the presentation was given in dual form. The directors, staff and all employees contributed generously to make the gift worthy of the occasion. As Mr. Warmington is so well known in the trade, we feel that many of our readers will join us in wishing him every happiness and prosperity in the future.

Obituary

MR. E. H. TYSON, who was for many years, until his retirement in 1935, the foundry manager of William Mills, Limited, Birmingham, died on April 10.

MR. S. D. CRAIG, a director of Robert Craig & Sons (Engineers), Limited, ironfounders and engineers, of Belfast, has died, aged 55 years. He was the youngest son of the late Mr. Robert Craig, founder of the firm.

MR. GEORGE RUSSELL, the oldest employee of Taylor Bros. (Sandiacre), Limited, who (as reported last week) was recently called upon to make a presentation to the directors of the firm on behalf of the workpeople, in celebration of the eightieth anniversary of the business, was found dead in his bed the following morning. Mr. Russell was 72 years of age, and had been with the firm for 55 years.

Company Meeting

Hadfields, Limited

The annual meeting of Hadfields, Limited, was held in Sheffield last week. MR. P. B. BROWN (deputy chairman), who presided in the absence of Sir Robert Hadfield, said that considerable progress had been made in carrying out the programme outlined by the chairman in his speech at the annual meeting last year. The most important items were: Foundry rearrangement and extensions; additional arc and high-frequency electric melting furnaces; new gantries and cranes for the rapid and efficient handling of raw materials; new departments for the increased output of ordnance; additional forging and heat treatment facilities; installation of large numbers of machine tools at Hecla and East Hecla works. The capital expenditure covering these items was approved in 1936, the year upon which the Government decided on its programme of rearmament. They had in mind the necessity for maintaining and increasing their output capacity for ordinary commercial work, and they had succeeded so far in doing so without materially inconveniencing their numerous customers. Statements to the effect that the steel manufacturers in this country were so fully occupied in the production of munitions of war that they where unable to undertake other work were very misleading and should be promptly contradicted. So far as their company was concerned they were in a better position than ever before to tackle work of this description, and if further calls were made upon them by the Government every effort would be made to meet them without any appreciable interruption in the output of their standard products. The extension to the open-hearth department came into operation during the year and had enabled them to amplify their steel output to the extent of 20 per cent., all of which was readily absorbed by the mills and forges. The electric furnace department worked to full capacity and the output was 50 per cent. greater than that of 1936. Due to the increased demands for alloy steel a new melting shop had been built and equipped with two 10-12 ton electric arc furnaces. No less than 63 per cent. of their total output by all processes was alloy steel. Despite the increasing calls for ordnance work, their output of steel for commercial purposes in 1937 had been greater than for many years past, being 22 per cent. over that of 1936. There had been a great amount of discussion in the Press and elsewhere on the wisdom of stabilising steel prices, many people asserting that the price schedules were much too high. There was, however, no valid ground for this assertion: the fact was that since 1935 the price of steel had advanced by only 33 per cent., whereas the essential raw materials had advanced at a much higher rate (iron ore, 67 per cent.: scrap, 39 per cent.: pig-iron, 55 per cent.: coke, 105 per cent.). It was to be hoped that by the stabilising of prices over a long period, on a national basis, a measure of confidence essential to the prosperity and smooth running of the country's industries might be established.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"M.H.T.A." (DEVICE).—Metal castings. Meigh High Tensile Alloys, Limited, 5, Grafton Street, Old Bond Street, London, W.1.

"TRIAMANT."—Metal goods. Tools & Drawing Dies, Limited, Shropshire House, 12-20, Pancras Street, London, W.C.1.

"NONCORALIUM."—Aluminium alloys. Walter Bushell King, Craven House, Kingsway, London, W.C.2.

"STERMET" (DEVICE).—All goods included in Class 5. Sterling Metals, Limited, 43, Northey Road, Foleshill, Coventry.

"KOROK."—Substances for use in the preparation of foundry cores and moulds. Garton, Sons & Company, Limited, Southampton Wharf, York Place, Battersea, London, S.W.11.

"BLUEX."—Electrodes. Murex Welding Processes, Limited, Ferry Lane Works, Forest Road, Walthamstow, London, E.17.

"KUDAMPRO."—Metal goods. I.C.I. Metals, Limited, Imperial Chemical House, Millbank, London, S.W.1.

Company Reports

Barrow Hematite Steel Company, Limited.—Dividend of 2½ per cent. for 1937.

Herbert Morris, Limited.—Interim dividend on the ordinary shares of 5 per cent., actual, free of tax.

Laurence, Scott & Electromotors, Limited.—Dividend on the ordinary and "A" ordinary shares of 15 per cent.

Babcock & Wilcox, Limited.—Final dividend of 6 per cent. on the ordinary shares, making 10 per cent. for the year.

Stewarts and Lloyds, Limited.—Dividend on the deferred stock of 12½ per cent. for the year 1937 and at the same rate relatively on the liaison deferred shares.

Ransomes & Rapier, Limited.—Profit for 1937, £27,137; brought in, £1,394; available after depreciation, interest on debentures, fees, etc., and an interim dividend of 2½ per cent., free of tax, on the ordinary shares, £21,906; dividend of 6 per cent. on the preference shares, £675; dividend of 5 per cent. on the ordinary shares, making 7½ per cent. (tax free) for the year, £18,250; to reserve, £5,000; carried forward, £2,981. Meeting, April 30.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Brookside Metal Company, Limited, 62, Eden Grove, Holloway, London, N.7.—Capital, £2,000.

David Evans (Manselton Foundry), Limited, Manselton, Swansea.—Capital, £5,000. Directors: D. Evans, W. D. Evans, and G. Rees.

Swift-Summerskill, Limited, Claremont Ironworks, Claremont Road, Halifax.—Capital £20,000. Directors: W. P. Eastwood, E. Blackburn and H. Summerskill.

John Farris & Sons, Limited, Belle Vue Ironworks, Shaftesbury, Dorset.—Capital, £6,000. Engineers and ironfounders. Directors: W. A. Farris and W. J. Farris.

Anglian Construction Company, Limited.—Capital £1,000. Engineers and founders, etc. Directors: S. A. Yallop, Woodlands, School Lane, Gorleston-on-Sea; and K. A. S. Piggott.

A. L. Dunn & Company, Limited, New Inn Bridge, Foleshill Road, Coventry.—Capital £4,000. Non-ferrous foundrymen, etc. Directors: A. L. Dunn, A. Goode and C. H. Marriott.

Maryland Alloys, Limited, 10, Arthur Street, London, E.C.4.—Capital, £1,000. To take over the business of aluminium refiners carried on at Sugar House Lane, London, E.15. Directors: W. Pearson, C. Raymond, E. Lumsden, G. L. Rapier, and A. H. Tresidder.

Contracts Open

Worsley, April 27.—Cast-iron street lamp pillars, for the Urban District Council. Mr. J. Howard, engineer, Town Hall, Walkden.

Horsforth, May 14.—24 yds. of 12-in., 1,844 yds. of 9-in. and 1,840 yds. of 6-in. spun-iron concrete-lined pipes, together with cast-iron concrete-lined specials, for the Urban District Council. Mr. J. E. Aldersley, waterworks engineer, Horsforth Hall, Horsforth. (Fee £2, returnable.)

Forthcoming Events

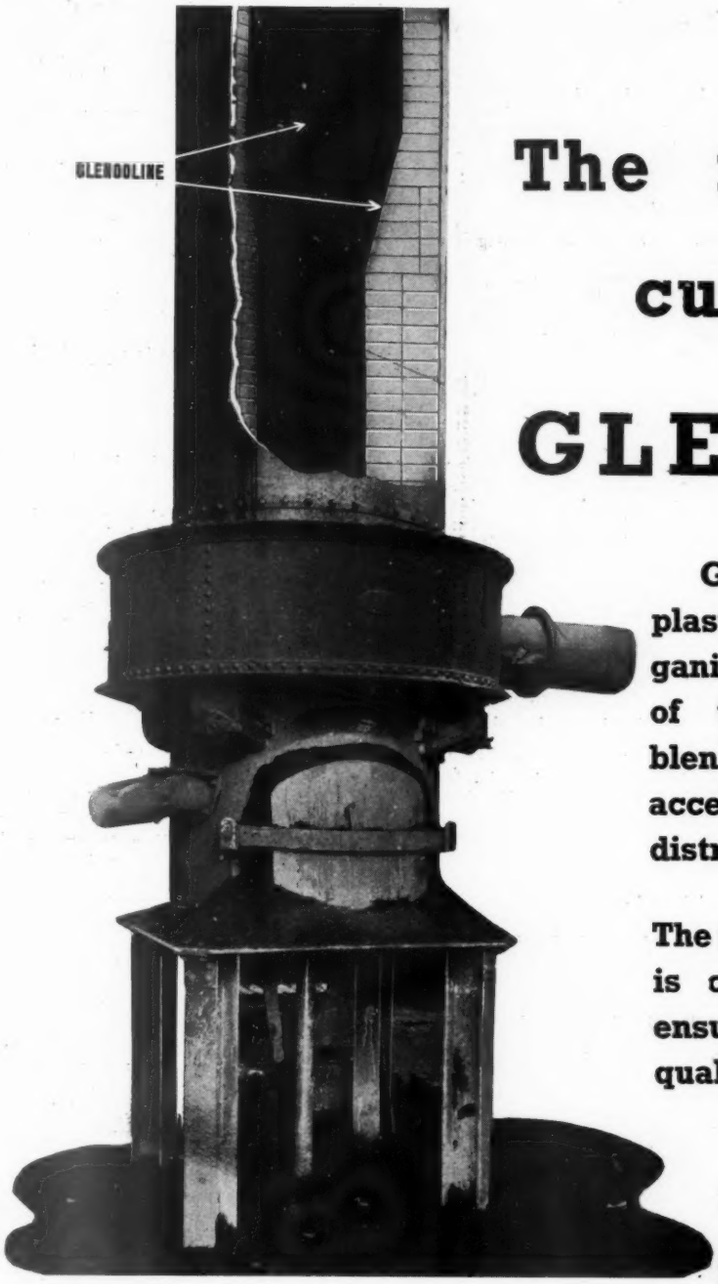
MAY 4.

Institute of Metals:—Annual May Lecture: "Plastic Strain in Metals," by Prof. G. I. Taylor, F.R.S., at Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 8 p.m.

Institute of British Foundrymen

APRIL 30.

West Riding of Yorkshire Branch:—Annual general meeting, at the Technical College, Bradford, at 6.30 p.m.



★ This photograph of a cupola shows a portion of the lining and illustrates the application of Glendoline for lining and patching.

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MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter)

BIRMINGHAM OFFICE: 5, Lower Temple Street. Telephone: Midland 6376. Telegrams: "Genefax, Birmingham." (Mr. G. Griffiths)

Raw Material Markets

The period immediately preceding the Easter holiday was a very quiet one in the iron and steel trades, and this week has been much the same. Many of the producing and consuming works closed down on Thursday last for practically a full week. It is expected that there may be a resumption of buying as soon as the holidays have been finally disposed of, as recent orders for defence purposes have helped considerably to strengthen the consumers' position.

Pig-Iron

MIDDLESBROUGH.—Shipments of foreign iron to the Tees have ceased, despite the fact that the reimposition of the import duty on foreign iron has not been officially announced as yet. Only small tonnages are being despatched from this district to Scotland, but light-castings foundries in the Falkirk area are busier and may soon be calling for heavier supplies. Makers are still restricting the output of foundry iron, but there is a surplus after contract requirements have been met. For delivery to Middlesbrough or Falkirk, No. 3 Cleveland G.M.B. is quoted at 109s., less 5s. per ton rebate.

Last year, when the demand for hematite outstripped the supply, export inquiries had to be sacrificed. This, of course, was very unfortunate, and the time has come when the need for this lost business is urgently felt. At the present time, there is very little in the way of foreign business coming to hand, while the home demand is quiet. Prices are based on East Coast mixed numbers at 132s. 6d., less 5s. rebate, delivered on the North-East Coast.

LANCASHIRE.—There is still little business outside contract deliveries, and consumers are only buying in small tonnages when the necessity to supplement their stocks arises. Light-castings makers and manufacturers of textile machinery continue to operate on the quiet side, although there has been some indication of an improvement in the former section. Current requirements do not account for the full production, and a certain amount is going regularly into stock. This position may shortly be eased somewhat, as several furnaces are being laid idle for repairs. Hematite is being taken up in moderate tonnages. For delivery to users in the Lancashire price zone, Staffordshire and Derbyshire brands of No. 3 foundry iron are quoted on the basis of 114s., less 5s. per ton rebate, with Northants at 112s. 6d. Derbyshire forge iron is quoted at from 111s. to 113s., according to the class of user. East Coast hematite, mixed numbers, is quoted at 140s. 6d., with West Coast material at 141s. Scottish iron is quoted at around 140s. and fair tonnages are passing into consumption.

MIDLANDS.—The light-castings founders are hoping that orders from the building trade will shortly show a marked increase. As yet, however, this section remains very dull. New business, generally, is quiet, and buying is restricted to small tonnages where contracts have expired. Consumers appear to have definitely made up their minds not to enter into further contracts at the present time. For delivery to Birmingham and Black Country stations up to the end of June, Northants No. 3 is quoted at £5 8s. 6d. and Derbyshire No. 3 at £5 11s. Supplies of forge pig-iron are more than ample to meet the existing demand; ironfounders are in possession of fairly heavy stocks, which are not being drawn upon very quickly, as many are working short time. Low-phosphoric iron and hematite are being taken up in larger tonnages. Low-phosphoric iron ranges in price from about £6 2s. 6d. to £7 2s. 6d., although slightly lower figures are being paid in some instances. For delivery to Midland stations, East Coast No. 3 hematite is quoted at £7 3s. 6d., with West Coast mixed numbers at £7 4s. 6d.

SCOTLAND.—There is no change to report in the condition of the market here. Consumers are well supplied with iron, and there is very little business being transacted. No. 1 foundry iron is quoted at 120s. 6d., with No. 3 at 118s., f.o.t. furnaces. Orders to the light-castings foundries in the Falkirk district have been slightly better during the past week, but this section of the market is still far from satisfactory. Although the local steelworks are working to capacity, they are not generally negotiating for additional supplies of pig-iron, being already covered for several months ahead. Mixed numbers of hematite are quoted at 133s., with Scottish basic at 107s. 6d. and Indian and English basic at 100s. per ton, all less 5s. per ton rebate, delivered f.o.t. steelworks.

Coke

Consumers of foundry coke are still holding out for reductions in prices, although there has been no indication of price changes from the makers. They may alter their minds, however, later with the continued lack of support. For delivery to Birmingham and district, best Durham coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 62s. 6d., according to quality.

Steel

Most consumers of steel are well placed with regard to supplies, and there is little prospect of much new business coming forward for some time. The rearmament programme will ensure that makers of heavy steel remain very active for a long time to come, but the demand for lighter products is still quiet. Semi-finished steel, also, is unsatisfactory, and will continue so until supplies of imported material have been consumed.

Scrap

With large supplies of foreign iron and steel scrap on hand, it will be some time before consumers re-enter the market. Until a short time ago, steelworks were taking up heavy tonnages, but the demand from this source has fallen away considerably. Transactions in all areas involve only small tonnages for prompt delivery.

Metals

Business has been very quiet on the London Metal Exchange. The Easter holiday extended from the close of business on Thursday, April 14, until the following Tuesday morning.

Copper.—Although there has been very little time for the transaction of business during the past week, a firmer tone prevailed following the receipt of the news that the strikers at the metallurgical factories in the Paris district had agreed to return to work. The outlook in the United States is now viewed rather more optimistically. Canada's copper production during February was 46,835,955 lbs., compared with 38,425,569 lbs. in February, 1937. The world stocks of refined copper during March increased by 11,118 short tons to 540,252 tons. The apparent world consumption was 159,000 tons, while the world output by mines and smelters totalled 162,000 tons. The world production of refined copper was 170,000 tons.

Metal Exchange quotations were as follow :—

Cash.—Wednesday, £39 18s. 9d. to £40 1s. 3d.; Thursday, £39 16s. 3d. to £39 17s. 6d.; Tuesday, £40 3s. 9d. to £40 5s.; Wednesday, £39 18s. 9d. to £40 1s. 3d.

Three Months.—Wednesday, £40 5s. to £40 6s. 3d.; Thursday, £40 2s. 6d. to £40 3s. 9d.; Tuesday, £40 8s. 9d. to £40 11s. 3d.; Wednesday, £40 5s. to £40 6s. 3d.

Tin.—Buying on industrial account, both at home and abroad, has been confined to very small tonnages, and the trend of the market remains uncertain.

Objections to the buffer pool are made in a memorandum sent to the Governor of the Straits Settlements by the Malayan Chamber of Mines (London) on March 9, but only just released for publication. Pointing out that in order to give effect to a buffer pool scheme it is proposed to vary Clauses 1 and 22 of the control agreement, the communication states that, if it is possible to vary that agreement in connection with a buffer pool, the Council is of opinion that it should with more reason be varied in order to revise the standard tonnages.

At a recent meeting of Chinese and European miners at Kuala Lumpur, a resolution was passed urging an immediate and substantial increase in the standard tonnage of Malaya under the control scheme.

Official quotations were as follow :—

Cash.—Wednesday, £170 15s. to £171 5s.; Thursday, £170 to £170 5s.; Tuesday, £170 15s. to £171; Wednesday, £170 to £170 10s.

Three Months.—Wednesday, £170 to £170 5s.; Thursday, £170 15s. to £171; Tuesday, £171 10s. to £171 15s.; Wednesday, £170 15s. to £171.

Spelter.—Consumers have taken little interest in this metal recently, and the break for the Easter holiday still further accentuated the quietness. Brassmakers are using high-grade metal quite satisfactorily, but galvanisers continue to be poorly occupied.

Daily market prices :—

Ordinary. — Wednesday, £14; Thursday, £14 1s. 3d.; Tuesday, £13 17s. 6d.; Wednesday, £13 18s. 9d.

Lead.—There is little change to report in the condition of this market. The demand has continued on a small scale, although it is thought likely that business will expand after the effects of the holiday have worn off.

Day-to-day quotations :—

Soft Foreign (Prompt).—Wednesday, £16 3s. 9d.; Thursday, £15 17s. 6d.; Tuesday, £15 12s. 6d.; Wednesday, £15 15s.

Scrap.—There has been an absence of fresh business during the past week, and it is unlikely that any substantial buying will take place for some time to come. Prices are unchanged.

Approximate selling prices for old metal :—New aluminium cuttings, £77; rolled, £63; cast, £33; foil, £88. Copper, £36 to £39; braziery, £33. Brass (clean), £22 to £25. Zinc, £7 10s. Lead, £12. Gunmetal, £37 to £38.

Service Life of Tin-Base Bearing Metals

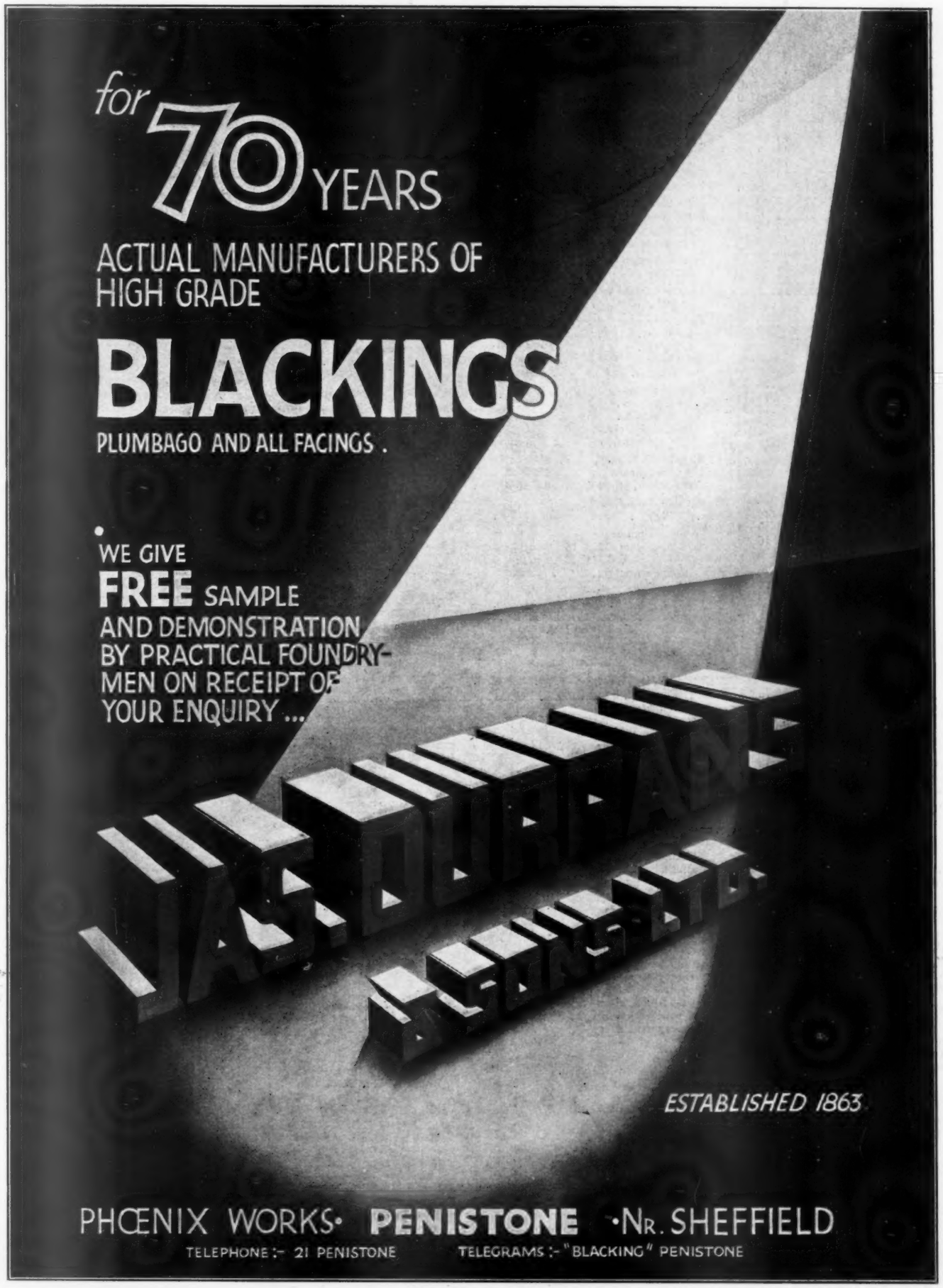
White bearing metals rich in tin have already a century of successful use behind them, and researches are now proceeding to ensure that they maintain their reputation under the more severe conditions of service that obtain to-day. In certain types of internal-combustion engine where the loading is very severe, white bearing metals have sometimes cracked and broken up. The study of these failures has led to modifications in design and operating conditions, and further progress should follow fresh knowledge.

D. J. Macnaughtan, Director of the International Tin Research and Development Council, in a recent Paper to the Institution of Mechanical Engineers, discusses typical failures and the factors underlying them. Tests revealed the degree of stress in white metal linings on thin steel shells due to thermal expansion and contraction, and showed to what extent the stress could be relieved by creep. Other probable causes of tensile stresses are discussed, and the author considers at what temperature the fatigue properties should be compared in view of results obtained at room temperature and 150 deg. C. with bearing metals containing additions of cadmium and lead. These experiments suggest that less than 2 per cent. of cadmium and no lead should be permitted in white bearing metals.

This Paper has now been issued by the International Tin Research and Development Council as Series A, No. 75, and copies may be obtained free of charge from Manfield House, 378, Strand, London, W.C.2.

Improving Steel Foundry Practice

We regret that several errors crept into the discussion on Mr. Deschamps' Paper. They are as follow :—On p. 311, column 1, 9 lines from the bottom, for "resembling" read "to form." On p. 312, column 2, under the caption "Synthetic Sands," for "30 or 35 permeability" read "90 to 120." An alteration Mr. Deschamps wishes to make refers to the fourth paragraph under the caption "Refractoriness," which is now amended to read, "If one had the sand of 10 lbs. compression, the higher the permeability for the same compressive strength, the better the castings came out of the moulds."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TELEGRAMS:- "BLACKING" PENISTONE

RAW MATERIALS—PRICE LIST

(Wednesday, April 20, 1938)

COPPER

	£	s.	d.
Standard cash	39	18	9
Three months	40	5	0
Electrolytic	44	0	0
Tough	43	15	0
Best selected	44	5	0
Sheets	75	0	0
India	56	17	6
Wire bars	45	10	0
Ingot bars	45	10	0
H.C. Wire rods	49	0	0
Off. av. cash, Mar.	39	16	4 29/48
Do., 3 mths., Mar.	40	0	11 12/48
Do., Sttlmnt., Mar.	39	16	7 23/48
Do., Electro, Mar.	44	0	1 7/48
Do., B.S., Mar.	43	18	7 1/3
Do., Wire bars, Mar.	44	8	7 1/3
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8d.

BRASS

Solid drawn tubes	11d.
Brazed tubes	13d.
Rods, drawn	8½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	7½d.
Yellow metal rods	6½d.

TIN

	£	s.	d.
Standard cash	170	0	0
Three months	170	15	0
English	170	0	0
Bars	172	15	0
Straits	172	5	0
Eastern	176	10	0
Banca (nom.)			—
Off. av. cash, Mar.	183	11	8 23/48
Do., 3 mths., Mar.	183	12	8 1/3
Do., Sttlmt., Mar.	183	11	1 7/23

SPELTER

	£	s.	d.
Ordinary	13	18	9
Remelted	11	10	0
Hard	11	5	0
Electro, 99.9	17	16	3
English	15	2	6
India	13	15	0
Zinc dust	19	0	0
Zinc ashes	5	5	0
Off. aver., Mar.	14	8	4 8/23
Aver., spot, Mar.	14	7	3 8/23

LEAD

	£	s.	d.
Soft foreign, ppt.	15	15	0
Empire (nom.)	16	8	9
English	17	15	0
Sheets, home	23	15	0
Do. export	20	0	0
Pipes, home	23	5	0
Do. export	20	12	6
Tea lead	32	5	0
Off. aver., Mar.	16	0	7 3/4
Aver., spot, Mar.	15	19	10 1/23

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	28	15	0 to 29	5	0
Do., V.M. ex-whse.	28	15	0 to 29	5	0
Rods			20	10	0

ANTIMONY

English	81	0	0 to 82	0	0
Chinese, ex-whse.			64	0	0
Crude, c.i.f.			37	10	0

QUICKSILVER

Quicksilver	12	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—						
25%				12	10	0
45/50%				12	0	0
75%				17	0	0
Ferro-vanadium—						
35/50%				14/- lb. Va.		
Ferro-molybdenum—						
70/75% carbon-free				4/9 lb. Mo.		
Ferro-titanium—						
20/25% carbon-free				9d. lb.		
Ferro-phosphorus, 20/25%				£21 to £22		
Ferro-tungsten—						
80/85%				5/6 lb.		
Tungsten metal powder—						
98/99%				5/7½ lb.		
Ferro-chrome—						
2/4% car.				34	15	0
4/6% car.				24	5	0
6/8% car.				24	0	0
8/10% car.				24	0	0
Ferro-chrome—						
Max. 2% car.				36	0	0
Max. 1% car.				38	5	0
Max. 0.5% car.				41	0	0
70% carbon-free				10d. lb.		
Nickel—99.5/100%				£180 to £185		
"F" nickel shot				£165	0	0
Ferro-cobalt, 98/99%				8/6 to 8/9 lb.		
Metallic chromium—						
96/98%				2/5 lb.		
Ferro-manganese—						
76/80% loose	£18	15	0 to 19	5	0	
76/80% packed	£19	15	0 to 20	5	0	
76/80% export			£22	0	0	
Metallic manganese—						
94/96% carbon-free			1/3 lb.			

Per ton unless otherwise stated, basis 2-ton lots.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	9 to 3	11	3	
Mixed iron and steel	3	6	9 to 3	9	3	
Heavy cast iron	3	8	9 to 3	11	3	
Good machinery	3	12	6 to 3	15	0	
Cleveland—						
Heavy steel, best	3	7	0 to 3	9	6	
Steel turnings	2	13	0 to 2	15	6	
Heavy cast iron			4	0	0	
Heavy machinery			4	5	0	
Midlands—						
Short heavy steel			3	12	6	
Light cast-iron scrap			3	2	6	
Heavy wrought iron	4	0	0 to 4	5	0	
Steel turnings	2	6	3 to 2	8	9	
Scotland—						
Heavy steel, best	3	5	0 to 3	7	6	
Ordinary cast iron	4	0	0 to 4	2	6	
Cast-iron borings	2	0	6 to 2	3	0	
Wrot-iron piling	4	5	0 to 4	7	6	
Heavy machinery			4	6	6	

London—Merchants' buying prices, delivered yard.

Copper (clean)	32	0	0
Brass	21	0	0
Lead (less usual draft)	14	0	0
Tea lead	10	0	0
Zinc	6	10	0
New aluminium cuttings	69	0	0
Braziery copper	29	0	0
Gunmetal	32	0	0
Hollow pewter	120	0	0
Shaped black pewter	83	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.

Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
,, No. 3	109/-
,, No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
,, d/d Birm.	144/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
,, No. 3 fdry.	111/-
Northants forge	107/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	110/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
,, fdry. No. 3	108/6
Lincs forge	107/6
,, fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	140/-
Clyde, No. 3	140/-
Monkland, No. 3	140/-
Eglinton, No. 3	140/-
Gartsherrie, No. 3	140/-
Shotts, No. 3	140/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to 13	15	0	
Nut and bolt iron	11	12	6 to 12	2	6	
Hoops			14	2	6	
Marked bars (Staffs) f.o.t.			15	15	0	
Gas strip			14	2	6	
Bolts and nuts, ¾ in. × 4 in.			17	10	0 and up	
Steel—						
Plates, ship, etc.	11	8	0 to 11	10	6	
Boiler plts.	11	18	0 to 12	0	6	
Chequer plts.			13	0	6	
Angles			11	0	6	
Tees			12	0	6	
Joists			11	0	6	
Rounds and squares, 3 in. to 5½ in.			12	0	6	
Rounds under 3 in. to ¾ in. (untested)			11	9	0	
Flats—8 in. wide and over			11	5	6	
,, under 8 in. and over 5 in.			11	10	6	
Rails, heavy			10	2	6	
Fishplates			14	2	6	
Hoops (Staffs)			12	4	0	
Black sheets, 24g. (4-t. lots)			15	15	0	
Galv. cor. shts. (,,)			18	10	0	
Galv. flat shts. (,,)			19	0	0	
Galv. fencing wire, 8g. plain			20	5	0	
Billets, soft, 100-ton lots			7	17	6	
Sheet bars			7	15	0	
Tin bars			7	15	0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11d.
Wire	12½d.
Rods	13d.
Tubes	18½d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	34/6
Durham foundry	39/6
,, furnace	32/6
Scottish foundry	42/-
,, furnace	35/6 to 37/6

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box		22/6
,,	28×20 ,,		45/-
,,	20×10 ,,		32/4
,,	18¾×14 ,,		23/5
C.W.	20×14 ,,		20/-
,,	28×20 ,,		42/6
,,	20×10 ,,		28/8
,,	18¾×14 ,,		20/9

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£11	0	0 to £12	0	0	
Bars-hammered, basis	£20	0	0 to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0 to £20	0	0	
Blooms	£18	0	0 to £19	0	0	
Keg steel	£30	0	0 to £35	0	0	
Faggot steel	£20	0	0 to £25	0	0	
Bars and rods dead soft st'l	£19	0	0 to £20	0	0	

All per English ton, f.o.b. Gothenburg [Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.	
Apr. 13 ..	39	18	9	inc. 10/–
„ 14 ..	39	16	3	dec. 2/6
„ 19 ..	40	3	9	inc. 7/6
„ 20 ..	39	18	9	dec. 5/–

Standard Tin (cash)

	£	s.	d.	
Apr. 13 ..	170	15	0	inc. 15/–
„ 14 ..	170	0	0	dec. 15 –
„ 19 ..	170	15	0	inc. 15/–
„ 20 ..	170	0	0	dec. 15/–

Spelter (ordinary)

	£	s.	d.	
Apr. 13 ..	14	0	0	inc. 7/6
„ 14 ..	14	1	3	„ 1/3
„ 19 ..	13	17	6	dec. 3/9
„ 20 ..	13	18	9	inc. 1/3

Lead (soft foreign, prompt)

	£	s.	d.	
Apr. 13 ..	16	3	9	inc. 3/9
„ 14 ..	15	17	6	dec. 6/3
„ 19 ..	15	12	6	„ 5/–
„ 20 ..	15	15	0	inc. 2/6

Electrolytic Copper

	£	s.	d.	
Apr. 13 ..	44	0	0	inc. 10/–
„ 14 ..	44	5	0	„ 5/–
„ 19 ..	44	10	0	„ 5/–
„ 20 ..	44	0	0	dec. 10/–

Tin (English ingots)

	£	s.	d.	
Apr. 13 ..	170	15	0	inc. 15/–
„ 14 ..	170	0	0	dec. 15/–
„ 19 ..	170	15	0	inc. 15/–
„ 20 ..	170	0	0	dec. 15/–

Spelter (Electro, 99.9 per cent.)

	£	s.	d.	
Apr. 13 ..	17	18	9	inc. 7/6
„ 14 ..	18	0	0	„ 1/3
„ 19 ..	17	15	0	dec. 5/–
„ 20 ..	17	16	3	inc. 1/3

Lead (English)

	£	s.	d.	
Apr. 13 ..	18	5	0	inc. 5/–
„ 14 ..	18	0	0	dec. 5/–
„ 19 ..	17	15	0	„ 5/–
„ 20 ..	17	15	0	No change

Imports and Exports of Pig-iron, Castings, etc., in March and the Three Months 1938, compared with March and the Three Months 1937

	March.		Three months.		March.		Three months.	
	1937.	1938.	1937.	1938.	1937.	1938.	1937.	1938.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	18,989	10,535	44,541	66,675	64,126	53,846	148,368	337,523
„ „ Other British Countries	—	—	5,070	—	—	—	21,167	—
„ „ Foreign Countries	2,294	79,973	7,100	185,716	14,458	418,056	44,197	987,287
Total	21,283	90,508	56,711	252,391	78,584	471,902	213,732	1,324,810
Castings and forgings	178	830	752	1,720	6,258	71,315	20,476	58,844
Cast pipes and fittings	78	69	307	274	2,271	2,504	7,846	8,542
Stoves, grates, etc.	47	58	186	185	6,834	6,610	19,220	18,043
Baths	1,039	857	2,284	1,970	24,574	21,663	53,927	49,863
Hollow-ware, all kinds	269	327	798	958	16,495	20,856	48,393	59,586
Exports.								
Pig-iron, forge and foundry	12,030	3,171	26,317	15,743	56,712	23,123	122,233	113,654
„ acid	4,234	1,546	15,426	7,988	23,461	10,730	74,419	61,524
„ basic	110	—	391	5	922	—	2,407	40
Total	16,374	4,717	42,134	23,736	81,095	33,853	199,059	175,218
Castings and forgings	217	201	884	503	7,706	6,753	31,778	21,586
Cast pipes and fittings, up to 6 in. diameter	5,584	3,918	13,585	13,801	57,080	55,236	145,519	172,011
„ „ „ over 6 in. „	3,025	3,228	8,293	16,557	22,840	35,161	65,817	167,894
Stoves, grates, etc.	1,093	738	2,963	2,179	59,411	43,388	159,434	126,195
Sanitary cisterns	343	257	901	727	10,620	9,999	28,172	28,231
Bedsteads, including tubes therefor	497	241	1,344	600	19,930	11,196	51,189	27,574
Hollow-ware	441	262	1,323	838	15,791	13,567	45,518	36,853

WILLIAM JACKS & COMPANY,

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CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

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All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ASSISTANT FOREMAN, experienced pump and engine castings. Full knowledge modern machine moulding and pattern design for production work. Also energetic Patternmaker.—Apply Box 866, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2

FOREMAN PATTERNMAKER required for large works in India. Candidates should have good experience in all branches of dry, green and loam moulding, be able to control and organise labour and have good knowledge of rate fixing and estimating. Experience in works engaged in the manufacture of cast-iron pipes and specials will be considered an advantage. Salary according to experience, free quarters provided, free passages, provident fund. Five-year agreement. Apply, by letter, with copies of testimonials, stating age, whether married or single, to: "ARBOUR," c/o ABBOTT, Eastcheap, London, E.C.3.

FOUNDRY SUPERINTENDENT required for progressive Midland malleable and grey-iron foundry. Age about 40. Must have long practical experience and technical training. Fully conversant with annealing and modern cupola practice. Experience of machine moulding an advantage. Apply with full particulars, stating salary required, to: Box 888, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Green Sand Moulder to take charge small Non-Ferrous Foundry, Romford district. Used to jobbing work. Permanency to suitable man. Write stating experience and salary to: Box 896, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Machine Shop Manager for large ironfounders in India producing general castings and pipes and specials. Applicants must be good organisers with an up-to-date knowledge of modern machine shop practice, and be competent to take complete control. Age about 35 years or under, five years' agreement, good salary and prospects, free passages, unfurnished quarters and medical attention, provident fund, and home leave on re-engagement. Apply by letter stating age and whether married or single to: "MACHINE," c/o WM. ABBOTT, LTD., 32, Eastcheap, London, E.C.3.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

YOUNG Foundry Metallurgist desires situation as Foundry Technical Assistant, or similar position. Excellent laboratory, works and technical training, also steelworks experience. (321)

FOREMAN PATTERNMAKER desires re-engagement. Considerable experience as journeyman and foreman on wide class of work, including valve, machine, tool, marine and steel castings. (322)

AGENCIES

ACTIVE AGENT with first-class connection, constantly covering London and 50 miles radius, seeks additional line, preferably Small Repetition Grey Iron or Brass Castings. Results absolutely guaranteed. Only well-established firms able to cope with substantial quantities entertained.—Box 856, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCY wanted for good class iron castings by London representative with excellent connection of 14 years' standing Good business can be introduced to foundry able to give good deliveries, and quality.—Reply to: Box 890, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LONDON Agency desired for a Foundry who are on the Government Lists, and who can undertake Repetition Work in Grey Iron and Aluminium.—Box 872, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

WANTED.—Shockless Jolt Turn-over Moulding Machine to take boxes approx. 36 in. by 24 in., Tabor or Ajax preferred. Lowest price and full particulars to: Box 894, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

OSBORN Roll-over Jolter Moulding Machine, to take boxes up to 30 in. by 24 in.; pattern draw, 10 in.; lifting load, 600 lbs. This machine is as new and has not been used. Price £170.—Write: Wilton House, Mellor, near Stockport.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

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ROOMS size, 12 ft. by 12 ft., 12 ft. by 9 ft., and 6 ft. by 6 ft.
Barrels: 54 in. by 36 in.; 36 in. by 30 in.; 30 in. by 20 in., etc.
Cabinet: 6 ft. by 4 ft.; 4 ft. 6 in. sq. by 3 ft. 6 in. sq., and 30 in. dia.
Table: 9-ft. Guttman.
Air Compressors in stock to suit any of the above plants.
Sand Mills: 7 ft. 6 in., 7 ft., 6 ft., 5 ft. and 4 ft. dia. pans.
Cupolettes: 10 cwts., 15 cwts. and 20 cwts.
Cupolas: 2 and 3 tons.
Morgan Tilting Furnaces: 250 and 400 lbs.
Heavy D.E. Grinding Machine: wheels 24 in. by 4½ in.
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'Phone: Broadwell 1359.

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15-ton Double-geared FOUNDRY LADLE (Jos. Evans), 6′ dia. across top x 6′ deep; ½″ plate; band round middle of body 10″ x 1″.

8-ton Geared FOUNDRY LADLE, outside dimensions type; 3′ 8″ dia. base; 3′ 5″ deep; ⅜″ plate; one hand bar 4¾″ x 1⅛″ steel; worm gearing.

Write for "Albion" Catalogue.

ALBION WORKS, SHEFFIELD.
'Grams: "Forward." 'Phone: 23001 (10 lines).

MACHINERY—*Continued*

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

'Phone **98** Staines.

2½- AND 1½-TON Morris Overhead Hand Cranes.
Tilghman Vertical Belt-driven Air Compressor, 130 c.f. at 100 lbs. w.p.
Riveted Steel Air Receiver, 6 ft. 6 in. by 2 ft. 6 in., 100 lbs. w.p.
HARRY H. GARDAM & CO., LTD., STAINES.

MISCELLANEOUS

ESTABLISHED Foundry in Eire manufacturing rain water goods and other castings, desirous of moulding Ranges, Mantel Registers, etc. Is any Foundry anxious to co-operate?—Apply to Box 892, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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FINEST FOUNDRY BLACKINGS AND FACINGS. Pure Ceylon Plumbago (Import direct), Finest Core Gum, White Dust, Parting Powder (Silica free), Pure Ground Carbon and Electrodes. Quality at reasonable prices. Orders repeated. Send for free sample.
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PENNINE WORKS,
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TABOR Portable Shockless Moulding Machine for 18″ × 36″ boxes Price £60

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Ladle, 5-tons capacity, NEW Price £44

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Large stock of TILTING FURNACES

Several small Foundry Grinders at £10 each

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